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ABSTRACT

This report by the Arizona Educational and Informational Telecommunications Cooperative (AEITC) is a review of Arizona networks, applications, Internet, organizations, and recommendations for telecommunications connectivity across the state of Arizona. It identifies the issues that exist when considering technology pertinent to public education and an Arizona information highway. Special emphasis is placed on the K-12 community to help plan, procure, and implement the technology needed to stay competitive in education and to keep pace with the information highway. The issues of statewide networking; connection to the Internet; and network management and support are identified and discussed. The following topics concerning networks are presented: industry standard protocol; goal(s) and priorities; industry standards for goals; measurements; standards challenges; criticality; performance; security; management; distribution; and interconnections. Next, the standards and recommendations for implementing the following network applications are given: fax; electronic mail; electronic conferencing; file transfer; information services; data types; and video conferencing. Other topics include: planning for cable installation; internetworking; network storage media; and network financial considerations. The goals and objectives of the AEITC are listed. Finally, areas for further study by the AEITC concerning networking are identified. A glossary and a bibliography are also included. (Contains 72 references.) (JLB)

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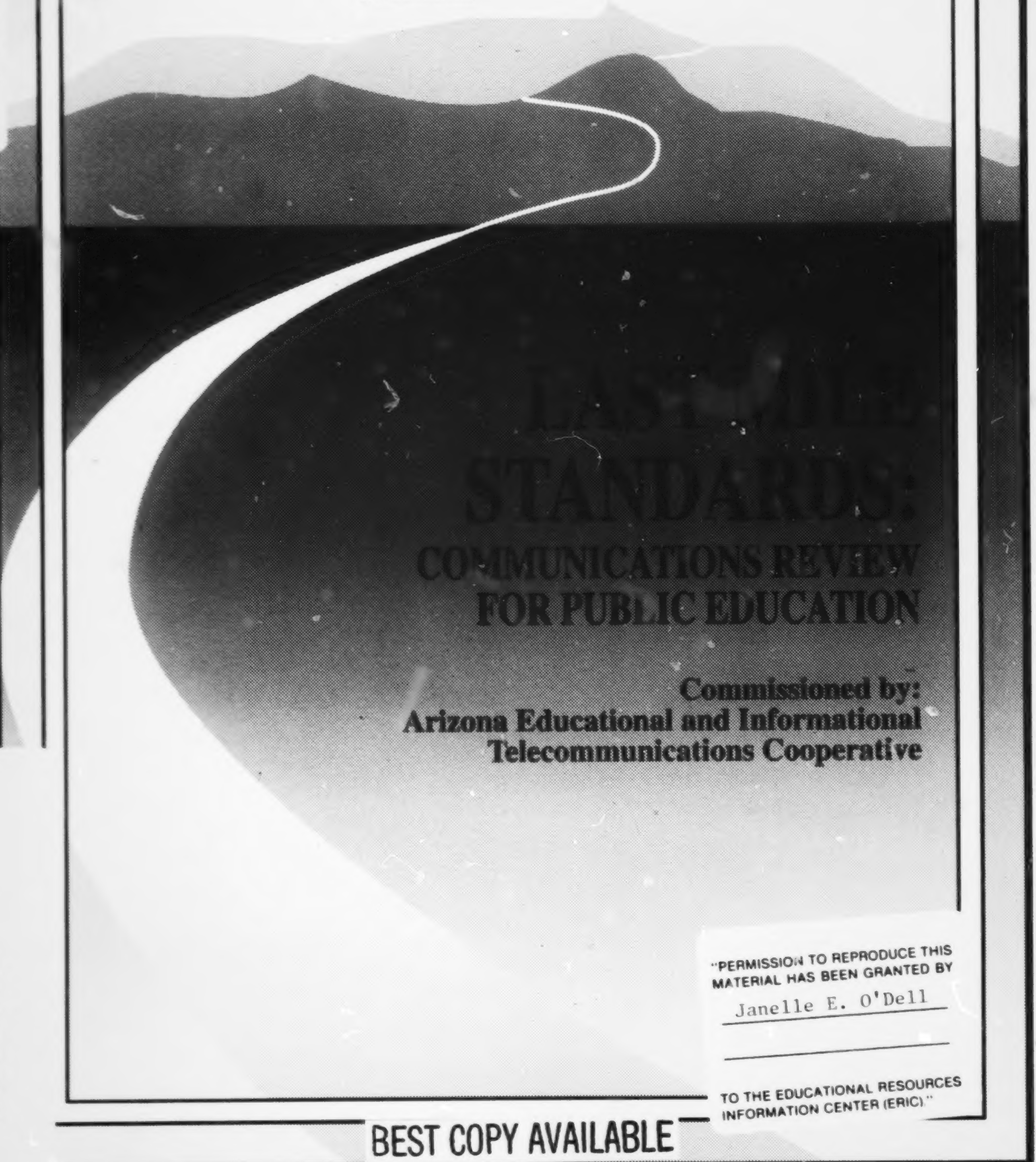

LAST MILE STANDARDS:

COMMUNICATIONS REVIEW FOR PUBLIC EDUCATION

Commissioned by:
Arizona Educational and Informational Telecommunications Cooperative

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INTRODUCTION

The source of wealth of our nation, the infrastructure changing from building highways to building information highways, and the global competitive nature of our enterprises demands new approaches to learning and technology.

President Clinton's speech on technology, specifically about information highways, states[1]:

> "We are moving in a new direction that recognizes the critical role technology must play in stimulating and sustaining the long-term economic growth that creates high-quality jobs and protects our environment."
>
> "We are moving in a new direction to create an educational and training system that challenges American workers to match their skills to the demands of a fast-paced economy and challenges our students to reach for resources beyond their classrooms. We are moving in a new direction to dramatically improve our ability to transmit complicated information faster and further. INVESTMENT IN A NATIONAL INFORMATION INFRASTRUCTURE and establishment of a task force working with the private sector to design a national communications policy that will ensure rapid introduction of new communication technology; IMPROVE TECHNOLOGY FOR EDUCATION AND TRAINING by supporting the development and introduction of computer and communications equipment and software that can increase the productivity of learning in formal school settings, a variety of business training facilities and in homes."

Charles Savage in Fifth Generation Management speaks on the basics of space and human time[2]:

> "Space is an easy metaphor to understand via organization charts which give an illusion of understanding how an organization works. It is much harder to see changing relationships over time, because no spatial diagram can easily capture what is going on. Yet our humanness unfolds itself in time, not space. We live in human time, at the intersection of our visions and knowledge. It is our dreams and remembrances that fuel our activities and give them content and texture. It is the tension between the two which motivates us. In the knowledge era, we plant our ideas in the fields of technology. Vision, knowledge, and a sense of timing are as important today as they were centuries ago."

With national attention now being placed on technology and information highways, it is evident that the state of Arizona and its public education system stands to accelerate its opportunity in greater access of information vital to the improvement of public education. How will Arizona prepare itself for this stream of information?

As identified previously in the article from The Washington Post, at present it is the full responsibility of the recipients of this information to be prepared technologically. Again, we face the discussion of THE LAST MILE. THE LAST MILE has been a continuing issue for the State of Arizona as well as all other states within the country since the notions of statewide connectivity and information highways arose in the 1980s. THE LAST MILE has been an issue for information providers since the beginning of the AT&T divestiture discussions of the 1970s. Since that time, it has become unclear even further as to who bears responsibility for THE LAST MILE particularly with the restructuring of the Regional Bell Operating Companies (RBOC's) and the advent of new technologies such as wireless communications.

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[1] Clinton, President Bill - Technology Address, March 1993

[2] Savage, Charles, Fifth Generation Management, 1990

The certainty which does exist is that communication users outside of major metropolitan areas and representative of economically disadvantaged constituencies continue to bear the brunt of this issue. In the case of public education, the issue gets further complicated by the move of state governments to continue to remove funding sources for last mile activities. In Arizona, K-12 public education has been an extremely controversial subject when it comes to education reform, national student ranking, and the preparedness of our children to compete in the workforce upon existing our educational institutions. The discussion of these issues, however, seems to skirt the topic of technology and an Arizona information highway which could assist in the advancement of all other public education agendas.

This document attempts to identify the vast number of issues which do exist when considering technology pertinent to public education and an Arizona information highway. Special focus is placed on the K-12 community as it attempts to stay competitive with the rest of the public education sector in terms of technology and its ability to connect to such a highway. As evidenced by the Arizona Educational Informational Telecommunications Cooperative (AEITC), a set of standards must be identified which will assist public educators and administrators to adequately plan, procure, and implement technology into our existing environments.

The areas of special interest addressed within this document are the following:

- Statewide Networking
- Internet Connectivity
- Technology Procurements
- Information Providers
- Networks/Applications

In formatting this discussion from the planning, procurement, and implementation perspectives, the K-12 community will be able to advance its efforts in integrating technology into its services and the deployment of public education.

"FIELD OF DREAMS"

The main challenges facing Arizona public education and the entire government sector within this state are the issues of statewide networking, connection to the Internet, and network management and support.

STATEWIDE NETWORKING

What is statewide networking? What will it do for Arizona? How will it affect both public education and the entire government sector? Who wants to participate? Who should take the lead? How can all the players cooperate? Who should design the network? Who should provide the network? What types of services should be delivered via a statewide network?

These questions may be the most frequently asked in Arizona during any forum which includes a discussion of a statewide network. Many attempts have been made, primarily within the last five years, to address these issues. Unfortunately, the state has only been partially successful in the execution of this desired network.

The main players who have expressed an interest in this area are the following:

- Arizona State Government
- Arizona Universities
- Community College Districts
- Arizona Department of Education
- K-12 Community of Learners
- Economic Development Entities

These interest groups are represented both individually and through various organizations:

- Arizona Educational Informational Telecommunications Cooperative (AEITC)
- Arizona Strategic Plan for Economic Development/ Governor's Strategic Partnership for Economic Development (ASPED/GSPED)
- Arizona Innovation Network
- Arizona State Public Information Network (ASPIN)
- AZTEC

The mood of this community of interest seems to be moving towards greater collaboration among organizations in sorting through the issue of a statewide network, e.g. Arizona state government has chosen to play a greater role within the AEITC organization. It is evident, however, that either an institution or an entity still must be identified to address specifically all of the questions surrounding this issue and move forward with an implementation plan. Several studies have been conducted over the last five years which lay the groundwork for such activity. Further action needs to be taken through an implementation plan.

Two opportunities exist for the state of Arizona to continue its efforts:

1. Within the last five years, individuals, entities and organizations have activated implementation plans towards the development of networks within the state that will facilitate voice, data and video applications. Many organizations, e.g. Northern Arizona University, have demonstrated the ability to plan, procure, implement and service their networks. These organizations have also demonstrated their ability to identify funding sources for such activities without impacting their state or local budgets. The AEITC has compiled an excellent overlay of these activities (see Appendix A). The opportunity here is to allow and actually incite these institutions to continue to grow their networks and incorporate additional elements which may not have been identified in their initial phases, e.g. add data services to video bandwidth. An entity such as the AEITC must accept the responsibility of monitoring these activities and ensure internetworking capabilities of all of these networks. This function may be the most important contribution that the AEITC could perform on behalf of Arizona's statewide telecommunications network. Should this opportunity continue to move forward, the K-12 community must focus more specifically on its capability of being internetworked into either regional or applications-based efforts.
2. The second opportunity which exists is for Arizona state government to assert its role within this effort through the creation of an agenda which not only addresses the internal needs of Arizona state government entities but also addresses these needs in combination with all other network

demands around the state. Governor Symington did mention, within his State of the State address in January 1993, that the need for a statewide network was paramount on his agenda. This agenda can set the stage for allocation of personnel, budgets and timelines which are necessary for the successful execution of such an endeavor. This opportunity must be accepted by all major players within this effort to avoid the risk of politicizing it. A statewide network must be viewed as a dynamic effort which will span the term of numerous governors, university presidents, school superintendents, etc. It is also necessary to identify the need for collaboration with the private sector in this effort bearing in mind, however, that information providers should not directly influence technology issues which may be self-serving in nature.

With either option moving forward, Arizona stands to benefit in many aspects:

- technological progress
- ease of communications
- acceleration of public education standards
- cost effectiveness
- economic growth

Current success has been realized from a "Field of Dreams" approach.

INTERNET CONNECTION

The greatest information source available in the United States is the Internet. The Internet is a hierarchy of networks resident throughout the United States and other countries which allows for communications between supercomputers for various purposes. This primary reason for existence is the need to pass valuable research data between educational institutions. There is also access to repositories of information, such as library catalogues, news articles, etc., available for anyone having an Internet connection. Although the Internet has greatest implications within the education environment, state and local governments play an important role in the delivery of Internet access to their communities.

"The Internet is an endlessly expanding frontier, infinitely transforming itself and constantly generating new, interesting types of applications." (Vinton Cerf, Internet Society President)

An excellent paper, "Low Cost, Robust K-12 Connections to the Internet" written by individuals from Colorado State University. The title of this paper is (see Appendix B). This document provides an easy-to-understand overview of the Internet along with information pertinent to the delivery of network services and the hardware pieces necessary for the delivery of a network.

Since the Internet is such a vital component of public education, connectivity between the Internet and the K-12 community is vital to any statewide network plan. Additionally, institutions and government agencies have been recognizing sizable cost savings from implementing network services which facilitate Internet connections due to the difference between interstate FCC tariff rates and intrastate Regional Bell Operating Company (RBOC) tariff rates. In the case of Arizona, this situation changed on May 1, 1993. Local tariff rates were decreased by approximately 25-30 percent. As a result, costs for T-1 services have become extremely competitive with interstate services.

The Arizona universities act as the lead for Internet connectivity and the integrity of the network being provided to its users. It makes sense for the universities to continue this role and expand it by including a larger base of Internet users in their planning and servicing activities. The largest volume user of Internet services may become the K-12 community in Arizona. As such, it should play a large role in ensuring that K-12 students interact in a user-friendly environment while being introduced to complicated network activities.

NETWORK MANAGMENT AND SUPPORT

Critical to the two previously discussed issues is the ongoing responsibility for network management.

All levels of networks can be mystical, frustrating and seemingly unachievable. K-12 schools have, by-and-large, purchased computers for specific purposes. Some schools have local area networks (LANs). Adding the potential for internetworking to some or all computers on a campus can be formidable as can be attested to by larger schools which have attempted this activity.

The answer to network support and management is the collaborative efforts of everyone. This includes the smallest school with one PC and modem or fax machine, to large districts with interconnected LANs, to the colleges, universities, state agencies and associated vendors.

But WHO specifically will be charged with initiating, sustaining, and supporting a statewide network? Other states have stepped up to the question in a myriad of ways, many working on pilot projects with local RBOC's and universities to achieve some level of K-12 connectivity. Some have been community- based initiatives. Some have grown without specific support.

A cooperative support and training plan should be developed which contains multitiers of technical support levels for each network product and procedure including, but not limited to

- internet access
- applications support
- information services
- addressing and security
- wide area networks
- local area networks
- interconnected networks
- networked computers and software

A similar plan should be developed to understand the potential and importance of being linked to world-wide resources for

- students
- administrative personnel, including school boards
- curriculum developers
- media centers
- teachers for understanding
- industry supporters

Vendor support is an important element in establishing and adopting standards. K-12 schools have limited resources and expertise to deal with networking products, and can't afford to make expensive mistakes.

Vendors implement standard products based on market demand and their own goals. K-12 schools may be way down the list on segmented markets for some large corporations, but the interest in education is very visible. K-12 schools should encourage vendors to adhere to international standards and not push proprietary products within their market.

In the area of internetworking, it must be the responsibility of vendors to ensure that their products interoperate with all in the network chain. Virtually all vendor products interoperate within their own domain, but a lesser number interoperate with others, requiring expensive gateways and protocol converters. The internal culture of vendor organizations is changing towards more open, standardized environments in response to consumer demand.

Vendors must also be willing to work together cooperatively for internetworking to be successfully implemented. Finger-pointing and not-my-problem syndromes may have existed in the mainframe worlds. It is inappropriate and unacceptable for K-12 networking. Adherence to de facto standards and migration plans to international standards must be encouraged and even demanded.

Partnerships of all potential and existing network vendors in support of K-12 networking must be created. Most employees of vendor organizations are parents who are interested in improving K-12 education. Many express desires to assist but don't have mechanisms to do so. Some ways they can contribute are:

- provide hardware, software and network resources
- assist technical staff
- sponsor projects
- serve on specialized forums
- deliver computer and network training

Network standards should be open for heterogeneous computers because the K-12 computing environments are not standard now and will increase in diversity as new, less expensive technologies emerge. A network specification for standards today may last five years.

Some of the questions that need to be asked are [3]:

Expandability
- Can the system accommodate more of a given technology?

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[3] Wittman, Art, *Network Computing*, March 1993

- Can the system accept and integrate new technologies?
- Does expansion require proprietary products or can commodity products fill the bill?
- What is the cost—in terms of time, people and money—to expand the system?

Performance

- Does the system provide enough bandwidth to meet present needs?
- Can systemwide bandwidth be expanded easily?
- Can bandwidth to a given station be increased easily?
- Does the system exhibit proper latency characteristics?
- Does the system offer sufficient access to bandwidth?

Scalability

- Can the system integrate easily into the greater network?
- Is scalability part of the system design?

Manageability

- Can the system shield one segment of the network from trouble on another?
- Is management built into the system, and can it be added to the system?
- Is management proprietary or standardized?
- Are the management features complete enough for the organization?
- Are the vendor's maintenance options sufficient for the organization?

A modular and multitiered approach will work for K-12 schools:

- Tier 1 - at the PC and workstation level
- Tier 2 - connecting clusters of workstations with departmental services
- Tier 3 - connecting campuses to each other
- Tier 4 - connecting to the outside world

Each layer has its own topology potential. LAN topologies can be:

- BUS - same physical path with serial access
- RING - devices are connected to a continuous loop
- STAR - devices are connected to a computer or central hub
- TREE - hierarchical networked nodes

For statewide K-12 access in WANs, the most expensive topology is dedicated links using STAR on the one hand and the MESH where devices are interconnected, similar to a crossword puzzle.

Some form of dial-up access for small schools which plan only a single PC or fax or voice access makes the most sense for startup. For LAN(s) connectivity, hubbing through a local community college/university or to the nearest wide-area link should be explored. An 800 toll-free telephone service needs to be provided for schools outside of the larger metropolitan areas. Pilot programs have shown that K-12 schools stop using network access when they are responsible for variable long-distance charges. For large, network-intensive schools, interconnectivity should be achieved via routers. It is unlikely that private companies will share bandwidth, but some publicly supported networks may be available on a shared basis. All are concerned that K-12 access could cause network performance problems and force them to upgrade capacity sooner than expected.

The backbone network should not be based on bridge or virtual addressing approaches. Bridged networks cause all packets to be delivered everywhere with the destination device being responsible for plucking packets from the network. Since the destination is not verified before the packets leave, the network can have "storms" of undeliverable packets.

The backbone should be securable by fixed address, and zonable or compartmentalized so all nodes are not accessible from all other nodes across a wide area network.

Even if the K-12 schools use dial-up mode predominantly, they should have the ability to manage the network. The basic approach for network management is to establish an open systems and network management architecture that is hierarchical in design and redundant in functionality. It will clearly define the areas of responsibility for both the schools and staffs along with problem escalation methods. The overall goal for network management implementation is to have the ability to determine the status, network utilization and problem notification/determination of any node, backbone component, or wide-area link that comprises the total interconnected network.

U S WEST COMMUNICATIONS—ARIZONA DIALOGUE

Government and public education entities play a large role in state communication issues, both internally and externally. Externally, the RBOC commands a tremendous amount of activity in relationship to availability and cost effectiveness of local and statewide services.

Arizona's RBOC is US West Communications. The Arizona services are directed by the state office. Marketing and service offices are located throughout Arizona to service customers. The marketing services provided today may be obtained either from direct sales and marketing employees of US West Communications located in Phoenix, Arizona, or through approximately 11 authorized agents within the state.

Since government and education customers are so numerous and spread around a large geographic area, it is difficult at times for all consumers to retrieve the same vital information when making decisions regarding networking, procurements or implementation of services. During the course of this study, numerous education entities were interviewed to determine the level of success and service which they feel they are receiving from US West. The topics of concern most identified are as follows:

- What are US West's plans for expansion of services in Arizona?
- Why is it so difficult to retrieve information which is critical to network planning?
- What does the state look like today in terms of types of central offices, fiber optic options, upgrade plans and forecasts on future issues?
- More technical information regarding existing services is needed.
- Why is the southern part of the state serviced by a separate organization from that of the northern section of the state (marketing support)?
- There does not appear to be any clear-cut approach to the way that contracts for services are administered. There does not appear to be any clear direction in migrating from services which are under contract.
- There does not appear to be any effort on the part of US West to attempt to work with the K-12 community in its quest for statewide networking.
- The agenda of the AEITC organization does not seem to be a priority of the company even though it is involved with all of the issues which affect US West service provisioning.

This document is an attempt to confront these issues and questions. All of the concerns are too numerous to address at this time. However, the document does discuss the most pressing agendas.

U S WEST CONTRACTS

There has been a tremendous amount of activity within the K-12 arena regarding network services procured from US West Communications in the last two years. These activities have been complicated by the fact that new technological services continue to become available at prices which school districts can now afford. The most common problem which the schools have run into is the termination of existing contracts, e.g. Centron contracts, while transitioning to digital switched services.

Up until now, the official position of US West has been to charge termination liability charges for the early termination of a Centron contract even though the customer is willing to contract for longer term digital switched services. After having investigated this issue, it was determined that the marketing headquarters of US West is considering a change in this policy. The problem up to this point is that management individuals responsible for the delivery of both Centron and digital switched services run separate internal operations which makes it difficult to confront this issue. A determination, although not committed at this time, is promised.

It is recommended that the AEITC and the Department of Education take a stronger approach to issues like this one since they may bring more pressure to bear on US West, or any other provider, than a local or remote school district can. A position document would be very appropriate for those making such decisions.

ARIZONA TELEPHONE COMPANIES/LATA STRUCTURE

At the time of the divestiture of AT&T, the United States was partitioned into Local Area Transport Areas (LATAs). This partitioning has usually followed state boundaries, with larger states being subdivided into additional LATAs.

Arizona was partitioned into two LATA's in regards to most services, primarily those of U S West Communications. There are borders of Arizona that are included in bordering states' LATAs and serving areas. (A map of Arizona with its LATA boundary has been included.) The primary issue concerning the location of the LATA boundary is simply the demarcation of local and long distance telecommunications services. Any traffic which crosses the LATA is considered long distance traffic, and US West is precluded from providing that service. There are approximately 10 - 13 long distance carriers authorized to provide services in Arizona.

To further complicate matters, there are local telephone companies within Arizona other than U S West. These companies include:

- Arizona Telephone Company
- Citizens Utilities Company
- Continental Telephone Company of the West
- Navajo Communications Company, Inc.
- Papago Tribal Utility Authority
- South Central Utah Telephone Association, Inc.
- South Western Telephone Company
- Universal Telephone Company of the Southwest
- Valley Telephone Coop, Inc.
- Rio Virgin Telephone Company, Inc.

A diagram of servicing areas has been included along with a cross-reference list which was provided by US West (see Appendix C). The complications which exist when addressing the issue of statewide networking and availability of services are quite obvious.

INFORMATION SOURCES

Aside from normal marketing channels, it may be difficult for the AEITC or any other collective group of consumers to retrieve information easily regarding technical details of current services and information pertinent to central offices and fiber optic services. Included in this document are a number of information files, again provided by US West for purposes of this discussion:

- Analog Private Line/ Infospan Technical Reference - Series Associated (a full discussion on analog services)
- "Conditioning" (why provide it for analog services)
- Digital Switched Service (general description and basic design issues)
- Arizona Central Office Data (identification of all US West central offices and how they are equipped, along with forecasted dates for upgrades)
- Phoenix Metro Fiber Map (as provisioned by US West)

The data provided (see Appendix C) are a good start towards the dissemination of information, particularly to the K-12 community, to act as supplements for training in the management and procurement of network services. Additionally, the central office data and fiber link schematic provide insights into the availability of services through US West for statewide networking and portray its ability to compete within this marketplace. A liaison for AEITC has been identified within U S West. The AEITC may register with the Consultant Liaison program for the dissemination of information. Additionally, an offer was made to assist the AEITC in setting up a video library to assist in this endeavor.

CENTRAL OFFICE COLOCATION

Later this year, US West will initiate colocation services within its central offices, upon demand, contingent on meeting certain specifications. The first interconnector is expected to be in service by the fourth quarter of 1993.

Two types of colocation are possible: physical and virtual.

> Physical colocation refers to the actual leasing of floor space within a central office for the placement of customer-owned equipment. Channel terminations may only be DS1s or DS3s, and the interconnector must provide a fiber connection to its serving area.
>
> Virtual colocation will include the leasing of US West equipment within the central office along with space. The interface is once again only a DS1 or a DS3, and US West will maintain all equipment. The interconnector will monitor and control circuits.

Any entity may apply for this opportunity, and requests may be for either office space or microwave towers. The minimum leasing of office space will be 100 feet. Rate elements are not standard. Therefore, all requests will be dealt with on a custom basis. Responses will include cost quotations, tenant improvements costs and any entrance structure which may be necessary.

A $7,000 application fee is necessary when filing for central office space; a $21,000 fee is necessary when requesting microwave space when and where available.

Central offices have been categorized into three zones, depending on density, which will affect the rate structure.

An important issue for the AEITC is the availability of these services to alternate providers of intrastate services. The AEITC and the K-12 community will undoubtedly see an increase in competitiveness for both the local loop and statewide network services.

INTERNATIONAL DIALING PLAN

A summary document for the "Implementation of Interchangeable NPA/NXX Code Capability" has been included with this document (see Appendix D). In 1995 all of North America will go through a change in the existing dial plans in order to relieve the shortage of numbering plans within the United States, Canada and many of the Caribbean administrations.

Details are highlighted in the enclosure. This issue is mentioned because any procurements of voice-switching mechanisms should be equipped with the software necessary for the integration of this numbering plan. All existing hardware will need to be upgraded to include such software. Thus, school districts should identify and investigate this issue with their vendors.

NETWORKS

BACKGROUND

Networks are becoming critical for the effective operation of public entities and, in particular, schools (see Appendix E). Networks provide the means

- for educators to communicate with other educators, staff and students
- to allow applications like progressive reading and writing curriculums to be delivered electronically
- to exchange course materials electronically
- to challenge geographic boundaries and time constraints
- to manage administrative functions more effectively

The network potential is to incite

- searches for research information across the Internet network
- exchange of work in progress
- the generation of ideas

Networking technologies are now starting to converge as the market demands more sophisticated linkages. A school may want to send state-required reports across a network and receive a satellite lecture without investing in duplicate technologies.

The RBOCs, AT&T, cable and wireless companies, and numerous manufacturers are scrambling to offer public and private network services in their facilities so these applications might be possible.

A driving force behind these efforts was the advent of inexpensive personal computers and workstations providing an intelligent device for transmitting information. People were no longer limited to just voice services. Previously, terminals logged on to large centralized computers, or mainframes, and received whatever the mainframe was programmed to do. Mini-and microcomputers allowed departmental systems to be built without mainframe reliance. Local area networks started to be installed to share data in local departments. Consequently, the driving force is now to have transparent access to information from a variety of sources, which requires more planning and sophistication for connecting the local or departmental computers to other entities.

NETWORKS

INDUSTRY STANDARD PROTOCOL

The most formidable example of transparent access to information is the Internet, a global network of research institutions' host computers which subscribers can access around the world. They communicate via Transmission Control Protocol/ Internet Protocol (TCP/IP). More than a million computers are linked with software developed to exchange data via electronic mail, downloading files, remote log-ins and doing remote searches against information collections (libraries, archives, etc.) using software programs such as Wide Area Information Servers (WAIS), Gopher and World Wide Web (WWW). Scientists are able to collaborate on experiments rapidly, with some significant medical breakthroughs becoming possible. The data highway, or NSFNET (National Science Foundation Network) was originally funded to link supercomputers at research and instructional institutions and for-profit firms when used for research purposes. Unix-to-Unix Copy Program (UUCP) is an alternative connection to exchange electronic mail and USENET newsgroups, excluding file transfers and remote log-ins. USENET is a linkage of worldwide computers to exchange USENET news or forums on many topics and are distributed around the world to which people may read and respond.

Noticeably absent from usage of this fertile educational ground are the majority of K-12 schools. Some schools have yet to purchase a modem, a fax machine or phone lines to connect into these networks.

The network discussion for K-12 schools is too important to be reduced to debates about which piece of equipment is the best and why. The overall standards presented here should be a call to action for standardizing on elements necessary to achieve interoperable networking. In the best of cases, it should kick-start a statewide K-12 project for linkages to the outside world.

While it may not be feasible to develop a statewide network all at once, a modular approach is practical and affordable.

NETWORKS GOAL(S) & PRIORITIES

The establishment of networking standards can be an expensive and difficult endeavor without a clear goal of what is to be accomplished or identification of applications. The goal(s) should track the mission statement of the school and be measurable and achievable. The top priorities should support the goal and mission in a direct and cost-effective way. Additionally, network planning may have curriculum and instructional implications not covered in this study.

SAMPLE GOAL:
- link K-12 schools to the Internet to participate in environmental studies around the world

SAMPLE GOAL:
- receive US & Arizona commodity surplus information for timely response for distribution of perishable goods

SAMPLE GOAL:
- stabilize the existing building of networks

SAMPLE GOAL:
- improve cycle time of applying for grants

SAMPLE GOAL:
- exchange Arizona science curriculum materials

SAMPLE GOAL:
- link K-12 schools to college networks so that education students can collaborate with teachers and other students

NETWORKS INDUSTRY STANDARDS FOR GOALS

Network World reported in its March 15, 1993, edition that the "Blueprints for Success for Goals of Strategic IS Plans" (based on responses from 100 *Network World* readers) are

83.3%	achieving interoperability among current systems
82.3%	moving to open computing or network standards
82.3%	improving communications among departments
80.2%	aligning IS and business goals
76.0%	implementing client/server or distribute processing
75.0%	reducing IS expenditures
67.7%	consolidating stand-alone networks
57.3%	reengineering business processes
54.2%	centralizing procurement

Although this report may pertain more specifically to the larger K-12 districts, it can certainly be part of long-term planning for the other end of the spectrum. Schools should identify goals which correlate to the "Blueprints for Success" and prioritize them in all phases of execution: planning, procurement and implementation.

NETWORK MEASUREMENTS

Event cycle-time reduction is at the core of most network goals and decisions. Using event cycle time reduction as a benchmark for technological decision-making will create the basis for further standard identification. Stalk and Hout in *Competing Against Time* say[4]:

> "Although the challenge to innovation is in originating new ideas, time is at the core of an innovation's success. Certainly, there cannot be innovation without new ideas. But innovation means change, and change is measured by time. The magnitude of change is measured as innovations per unit of time. Timely execution is critical to successful innovation and high rates of change. Thus, it is timely execution as much as ideas that is the challenge to innovation."

Standardizing on key network elements is consistent with cycle-time competition.

STUDY ASSUMPTIONS

The basic assumptions identified during the course of this study are

- K-12 schools want to connect to the following:
    - computers and devices within the walls of the school
    - schools together within a district
    - districts to each other
    - districts together to the state
    - other state educational institutions and public entities
    - worldwide research and data repositories
- K-12 schools may not have the funding/expertise to achieve some or all of the above connections
- K-12 schools would like to develop a plan to position themselves to attach to any new network like the National Research Education Network (NREN) or the local colleges to network to other institutions
- It is advantageous for K-12 schools to standardize where possible for network linkages to outside entities
- It is optimal for K-12 schools to agree to coordination and cooperation in the quest for network access

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[4] Stalk and Hout, *Competing Against Time*, 1989

NETWORK STANDARDS CHALLENGES

Pioneers in networking pilot much that is new and innovative while sanctioning de facto standards. This report will attempt to select the most practical current standards with respect to internetworking which will ensure compatibility to existing de facto networks. It behooves the K-12 community to step into the fray, intersecting technology at the most appropriate, if not optimum-time (optimum being when everybody has agreed to standards).

APPLICATIONS SELECTION

The applications chosen for a statewide K-12 initiative will have many challenges.

For example, if electronic mail is selected, the following issues must be resolved:

- desirable baseline functionality
- selection/rejection of local electronic mail packages and protocols
- electronic mail gateways and standardization
- security of electronic mail
- privacy and policy on electronic mail
- electronic mail - physical, logical and subscriber address conventions
- directory services, including nickname translation
- additional hardware/software purchases

RECOMMENDATION

Network decision-making should be applications driven. The simplest of applications for trial on a statewide basis would be electronic mail and electronic conferencing. Video and full motion applications should be separate focuses and projects.

The selected applications should be available at all levels including voice activated with Telecommunications Device for the Deaf (TDD) services for the hearing- and sight-challenged students.

A baseline electronic mail service should be defined, including elements from the defined issues and selection of standard packages at the local level. For interconnection to the outside word, select SMTP (Simple Mail Transfer Protocol) based electronic mail gateways and use TCP/IP access.

Building from an application to a network is the most important and logical step in designing a network. Many networks are designed in a reverse mode, running the risk of not identifying the successful criteria components for the network. This section will start from the common to the more complex applications necessary in the development for statewide standards.

NETWORK CRITICALITY

BACKGROUND

Network designs depend on the reliance of the K-12 schools on external networked applications. Network criticality can be measured by

- impact of loss of the network for a few hours, a day, a month
- application design for continuance of work in network outages
- lost opportunity for educational initiatives
- reliance on networked applications for day-to-day K-12 business
- impact of loss of information repositories

As more applications and information are added to electronic media, the network access will become more critical. Collections of data are being rapidly added to CD-ROMs which are beginning to be networked between libraries and librarians. Once reliance on specific data for transcripts and student records has been established, the backup mail systems may not be sufficient.

The Internet is functioning by linking millions of computers together, so the computers and networks in the network links must be operational. If a K-12 school connects directly to the Internet for full Internet services, then it should maintain the same availability. Arizona State University (ASU) and University of Arizona (U of A) are both Internet network nodes and are committed to provide stable network services.

STANDARDS

The standards for measuring network criticality are emerging from the mainframe world, which have extremely high standards. Local area networks tend to be home-grown and grow without much thought given to uptime. With the advent of internetworking, the model from the mainframe world is more appropriate.

RECOMMENDATION

If statewide standards are adopted to link to the Internet, the intermediate nodes should have a high level of availability, or the K-12 schools linking to the networks will be dissatisfied. The entity providing Internet connectivity should have an implementation plan to keep the network as a "mission-critical" application. This may include finding backup network links from private industry and/or sharing network resources with community colleges and universities. From a K-12 school's perspective, some network outages in the range of hours to one or two days may be tolerable, so the link between them and the intermediary is not so important.

NETWORK PERFORMANCE

BACKGROUND

The following are elements of network performance:

- the size of messages and files being sent/received
- the number of simultaneous messages and files traveling
- the mix of files and messages and data types
- the bandwidth available
- the speed of the devices handling network traffic
- the applications and operating system instruction executions
- the amount of error recovery on the network
- the functioning or dysfunctioning of network entities
- the path a message or file takes from send to receive
- the message and file-delivery protocols
- the wiring schemes, both inside buildings and across common carriers
- the traffic and message movement design
- the flexibility to reconfigure the network

Everything counts in network performance. The network performance in total is only as good as the weakest or slowest link when in the data path. If a K-12 school has 2400 baud modems for dialup or switched services, the maximum performance will be no more than 2400 baud. If a network protocol is causing network "storms" by transmitting all packets to all locations, then the bandwidth will be consumed with constant packets with no destination, and real data traffic won't get through. A broadcast network for one to many transmissions may have performance characteristics quite different than traditional data networks and may or may not co-exist. If the protocol or component is inefficient or slow, the entire network will be slow.

STANDARDS

The standards for network performance are usually published as potential throughput for different protocols and media. Token ring has 4 and 16 Mb throughput, Ethernet has 10 Mb, and Fiber has 100 Mb. In actual practice, the computer devices that send and receive the data have restrictions in In/Out (I/O) architecture only, allowing data transfers at a fraction of those speeds. When operating systems and applications are loaded, the speed goes down even more. All reasonable approaches for this most important measurement are difficult.

RECOMMENDATION

Standardize and plan for performance from a PC or workstation perspective. Make the response time reasonable and constant for interactive sessions and make the files arrive reasonably fast. The public network backbone is the most expensive piece which may be a gating factor for what is achievable for network performance. With careful management of the applications utilizing local PC's for part of the workload, a high performance internetwork is achievable for K-12 Schools.

NETWORK SECURITY

BACKGROUND

Network security becomes a larger issue for K-12 schools when internetworking occurs. If a K-12 school remains isolated or self-contained with no modems attached to their computers, then the likelihood of security breaches are minimized.

PCs with modems in the hands of hackers may create havoc in a K-12 computer system. An unsecured modem-equipped PC on an interconnected network may cause all the computers on the network to be vulnerable to hacker penetration. K-12 students may attempt to hack into other school's computers.

Some of the security issues are:

- modems with send/receive functions
- personal computers with no security systems
- personal computers left on overnight
- personal computers with internal modems
- computer viruses from bulletin boards and borrowed software
- password and security files shared or unprotected
- phone wiring closets publicly accessible
- sensitive data unencrypted and unprotected
- inadvertent dissemination of sensitive data

Security protection needs to be built into a network system before it is implemented.

STANDARDS

Industry tracks the commercial implementation of the military standards written by the National Institute of Standards (NIST), especially in the area of public key encryption. Security standards have evolved from accepted security practices.

RECOMMENDATION

A security self-audit should be developed for networked systems so each K-12 school goes through a checklist of security issues and potential ways to deal with the issues. Breach of security should be assessed with the loss potential factored into proposed security-action items. A reasonable approach would be to publish a set of security practices on internetworked environments, create a security training session for network staffs and propose a method of isolation for security problems. For example, make the backbone internetwork secure and build compartmentalization into the topology for each school or district, so that if one school is penetrated, then no other school or institution on the network can be penetrated.

NETWORK MANAGEMENT

BACKGROUND

A network design without some semblance of network management built in will by definition be unsupportable. Network management tools have existed for different components of an internetworked environment, but few tools have emerged that are comprehensive. K-12 schools connecting to the Internet must have the assurances that network events are recorded and tracked so the networks can be successful. While the Internet has grown with little overall management, the research institutions and universities have used it enough to have assembled a group of collective knowledge on its management.

Proprietary networks such as Systems Network Architecture (SNA) or DECNET have excellent tools for network management for their own networks, but offer little for Internet-like networks. Routers, bridges, concentrators, LANs and computers have network management entities that may or may not communicate to the industry standards.

STANDARDS

The de facto standard for network management is Simple Network Management Protocol (SNMP). The Common Management Information Protocol (CMIP) for Open System Information (OSI) has not been prevalent.

RECOMMENDATION

Standardize on SNMP as the network management protocol for TCP/IP internetworking for the Internet backbone. There will be a consistency within the K-12 environment as it connects to the Internet. Within a school environment, choose a network standard consistent with the equipment and existing wiring infrastructure.

NETWORK DISTRIBUTION

BACKGROUND

If connecting K-12 schools to other locations is a goal, then Arizona's challenge is geography. The financial realities encompass the distances of many K-12 schools from the population centers, thus increasing the Wide Area Network (WAN) costs. Most network providers service areas where populations are dense. Some schools, such as Havasupai, may never get network connections because of its location. It's also a financial reality that K-12 schools in sparse areas have no funding for networks. The schools that can afford the services with local lines, such as Maricopa and Pima County schools, have numerous choices, including wireless hubs.

The most practical way for K-12 schools to interconnect is through public/private partnerships with entities maintaining network services. The Arizona Lottery has network links to virtually every location in Arizona. The Cable TV companies have wired a significant number of households and schools, albeit one-way broadcast. The electrical companies have services wired throughout their service areas including extensive fiber optic links. U S West and other local companies go to every K-12 school within their serving areas.

There are many network design solutions for K-12 schools which only allow communication inside a building and/or even between buildings. K-12 schools may have existing connections to city and county public entities requiring adherence to their standards.

STANDARDS

For distances greater than a campus collection of buildings, WANs are required, usually purchased from Public Network Providers. Some private networks exist along with some hybrid networks consisting of partial private and partial public services. Virtual private networks are not private but have the appearance of being private (shared but session dedicated bandwidth).

Wide Area Network Transmission Media:

- MICROWAVE requiring towers, line of sight and FCC approval
- COPPER wires
- FIBER optics based
- WIRELESS cellular, pagers and personal communicating devices

Wide Area Network Circuits

- Switched 56kb (dialup)
- Fractional T1 (between 64 kbps and 768 kbps)
- T1 digital (1.544 bps)
- T3 high bandwidth digital (45 Mbs)
- X.25 packet switching (prevalent in Europe)
- High Speed Circuit Switching (HSCS) at T1 and T3 speeds
- Frame Relay fast variable packet switching from 56kb to 2 Mbs

Protocols:

- TCP/IP- defacto standard for Internet
- OSI-de jure standard for networks
- SNA-most commonly implemented proprietary standard-IBM
- X.25-most commonly used network in Europe
- DECNET-proprietary network for Digital
- Others (mainly proprietary)

WAN links in Arizona are controlled by US West, with links going outside the state borders. They are sold by AT&T, Wiltel, Sprint, MCI and some small carriers. With a few microwave exceptions, the media are phone lines or copper.

For Metropolitan Area Networks (MAN) with distances within a city but outside a campus, the same protocols apply. The media and providers may vary with offerings of:

- FDDI (fiber-distributed data interface 100 Mbs)
- FDDI-II (circuit-switched service handling asynchronous and isochronous needs of voice and video)
- radio & wireless
- microwave
- copper-twisted pair-phone line

NETWORK INTERCONNECTIONS

BACKGROUND

The fundamental issues for interconnection involve hardware and software selection:

- protocols to support
- physical connections to support type and volume of traffic
- network management
- ease of configuration
- security

STANDARDS

Specialized equipment for connections are needed:

- Smart hubs - 10Base T standard for Ethernet LANs offering basic management information
- Advanced hubs - connects multiple LAN types, routing, and sophisticated management (sometimes with switching)
- Routers - intelligent devices which can automatically route data among local and remote LANs
- Multiprotocol routers - route data at gigabit-per-second speeds, provide advanced network management and support high levels of redundancy and fault tolerance
- Bridges - best suited for sending data over non-routable protocols, such as IBM's NetBIOS and Digital Equipment Corp.'s Local Area Transport
- Converters - to consolidate traffic from IBM Systems Network Achitecture (SNA) or other proprietary packages with TCP/IP networks
- Gateways - computers that interconnect and perform protocol conversion between different types of networks
- CSU/DSU - transmission and termination for digital network service

For connection of networks between buildings and within buildings, the media are the same with coaxial or thicknet cable added. However, additional protocols flourish:

- Novell IPX (Internetwork Packet Exchange)
- IBM Token Ring
- Artisoft's Lantastic
- Unix driven TCP/IP
- MacIntosh Appletalk & Localtalk

The issues at this level are

- installed base
- distances
- types of computers used
- applications on the computers
- connections to other institutions

In order to keep from running cable all the way from each PC to a central location, concentrators have been developed that hub wires. To extend cable beyond specifications, repeaters have been installed.

To allow local area networks to go between each other in the same and separate buildings, bridges were developed which ship like protocols in broadcast mode.

To allow groups of local area networks with dissimilar protocols and systems to interconnect, routers which add addressing and security characteristics to the networks have been prevalent.

RECOMMENDATION

Use of TCP/IP as the primary protocol for interconnection to be consistent with the Internet still provides a variety of hardware selections. It is robust enough to handle large volumes and types of traffic. It supports diverse connections and has management capabilities, and, with the appropriate selection of equipment and software, it has its security addressed.

Similar equipment and strategies should be used to ensure supportability, interoperability, scalability, and security at the interface on the local campus.

If no existing equipment has been installed

- for WAN connections, use TCP/IP so interconnection to other locations can be done with minimum protocol and equipment conversion. Use statewide fiber, microwave, or satellite services where they exist. Use land-based lines. Use the Internet and its broad portfolio of network connections for connections to outside state locations.
- for Metropolitan Area Network (MAN) connections, choose fiber links if available and if the cost of equipment is financially feasible.
- for interbuilding systems, use fiber, coaxial or wireless Ethernet depending on distances and obstructions.
- to wire a building use a fiber backbone along with copper and 10BaseT links, Ethernet from the backbone to the servers/devices, and concen-

trator hubs for reducing cable length runs.
- use wireless LAN devices when office moves occur often or major changes are planned.
- to interconnect LANs, use bridge-like devices (for like LANs) or routers.
- to link LANs to the outside world, use routers.
- to link PCs together use a server or dedicated PC for outside connections (security implications).
- for a single PC dialup access, use a Hayes compatible modem with error correction and compression for speeds up to 56kb.

Some advanced networks are creating sparks in publications including
- ISDN - mixed media digital network
- B-ISDN - broadband ISDN based on ATM
- ATM - asynchronous transfer mode (good for video) cell-based providing bandwidth on demand for SMDS
- SMDS - Switched Multimegabit Data service
- SONET - Synchronous Optical fiber-optic network for B-ISDN transport

These networks are largely unavailable to Arizona customers for the next one to three years. To get acceptance, an RBOC conducts pilot projects with large, strategic customers. With the exception of deployment of fiber rings, not much is happening or anticipated at the present time.

APPLICATION: FAX

Networks are exploding in usage. The simplest application of networks is the integration of a fax machine where a device on one end communicates a scanned image to a device at the other end. The manufacturers involved with the fax market continue to experience great success through the evolution of the following factors:

- integration of a common standard, GROUP-3
- marketing of equipment at a cost less than $1,000
- user friendly equipment - "plug and play"
- utilization of existing phone lines
- bypassing traditional computer systems
- identification of a need for rapid document exchange

The result has been the purchase of over 10 million fax machines in the U.S. over the past few years.

The fax process involves a scanner converting a document to a GROUP-3 or GROUP-4 bit-mapped image and shipped across a phone line to a receiving fax for printing only.

STANDARDS

GROUP3 fax still is dominant, with fax support for GROUP-4 starting to appear. There are no standards for the content of the page.

Fax traffic runs over public networks, to U S WEST and then to nationwide carriers.

Some fax traffic is transmitted over cellular phones for those equipped with the appropriate modems and services. To use fax, a phone line must be available, usually on a dedicated basis. The cost for the network is then the basic phone line charge plus any long distance charges which may be incurred.

RECOMMENDATION

Use GROUP-3 until the rest of the world changes.

FAX SERVICES

The ubiquitous fax machines have spawned new service offerings:

- fax back or automated document faxing by which a touch-tone phone or voice-activated unit sends a request for a faxed document
- fax electronic mailboxes to store incoming/outgoing faxes for later dialup access
- combination of fax/laser printers/copiers/answering machines and computers

The drawbacks of using fax services are

- The image sent is bit-mapped and therefore not editable. Some software and devices are emerging from Calera, for example, that will optical character recognize the document and convert it into a word processing form.
- The fax received is fuzzy and sometimes unreadable and uncopyable.

Fax services may be creatively combined with voice mail to achieve greater levels of customer satisfaction. Certain manufacturers have boards for PCs to send and receive faxes in place of a fax machine. If one has a PC, it may be less expensive to buy a board and modem rather than a fax machine. The PC must be networked via a modem. If only a fax machine exists, then explore the fax/voice combination services. Some on-line services allow a fax to be sent from a message for a nominal fee ($1-$2 per page) without having a fax machine, but the on-line service fees must be paid as well.

All of the combination services have network implications. Bit-mapped fax images are not small to send. Each page may represent 500k bytes without compression which must be factored into the network performance plans.

RECOMMENDATIONS FOR FAX NETWORKING

Some 95% of documents created start out as a PC- or MAC-created file, which has been printed. This type of document can be sent across a network as an attachment and printed on a laser printer at the receiving end. This improves the quality of the print, the speed of transmission and the speed of transmission and gives the recipient the ability to edit the document and respond. Electronic mail can be a substitute for faxes in many instances. When documents are not in electronic form or have drawings, electronic mail will not work. Electronic mail can extend fax-like services to computer users where fax is unavailable.

Fax traffic is the same as voice or data with the caveat that uncompressed fax may be large. If a statewide backbone for voice and data becomes a reality, then fax traffic could be a component on the network, thereby saving some long distance and local phone charges. Some small schools may be able to participate in fax combination services where it might be too expensive if done alone.

APPLICATION: ELECTRONIC MAIL

BACKGROUND

Electronic mail tops the list of applications demanded of networks. Although electronic mail has not grown as fast as fax services, it is starting to show the same signs of growth acceleration. An estimated 50 million+ households in the U.S. have PCs or MACs and roughly 10% have modems, both of which are necessary for electronic mail.

Electronic mail has been predominantly proprietary in nature within a hardware vendor's product lines. It is flourishing in local area network environments with a need and demand to get beyond those boundaries. LAN versions of mainstream software are de facto.

STANDARDS

In the past, electronic mail vendors have touted and sold proprietary systems requiring investment in mainframe computers thereby limiting their availability to all but the largest of users or schools. The standards are now starting to dominate.

The industry standard for electronic mail is the X.400 1988 version with X.500 directory services. The Internet standard for mail, Simple Mail Transfer Protocol (SMTP), has been the de facto standard for Universities and Research Institutions. Electronic mail offerings based on either will work, but the X.400 1988 is still emerging and is not fully operational. The 1984 version lacks the basic functionality of directory services and binary mail enclosures. The X.400 and other standards speak to the way mail is formatted, addressed and sent. SMTP mail has been running many years, interoperating with many computer systems. Many mail packages for personal computers and local area networks have emerged with attractive features (windowing, icons, etc.), such as cc:MAIL, Microsoft Mail, QUICKMAIL and many others. They are useful in a local environment, and it would behoove a school with multiple personal computers and LANs to look at these packages. However, when a school wants to connect to another school, another district, another educational institution or another public entity, standards must be adhered to or the mail system will not interconnect.

RECOMMENDATION

The basic recommendation is to use an SMTP mail derivative or a local mail package supporting SMTP or X.400 interfaces. Some public domain electronic mail packages are available from the Internet and some universities or colleges. The mail package should support or have plans to support the Multi-Media Mail Enclosure (MIME) standard including text, graphics, voice and eventually video. The University of Washington has a public domain electronic mail package called PINE which fits the criteria. Consider a joint project to develop an easy-to-use interface with Macintosh "Look and Feel" for students. In lower primary grades, use the model Broderband developed for KidPix.

Mail servers may be a component in the electronic mail system requiring the purchase of hardware, software and disk space. Electronic mail messages are typically small, but their archive and store/forward will require additional space. Memory and speed of the mail server are also issues. The recommendation is to consider electronic mail servers when the number of electronic mail users with computers grows beyond a handful and when they will be extended to other networks. If an electronic mail system is robust and growing, using local area networks for connectivity, then a device to convert to outside standards and to protect against security penetrations may be in order. Most mail packages have interfaces to SMTP.

If a K-12 PC or Macintosh is connected directly via modem to the Internet using TCP/IP protocols, the PC is wide open to any hacker. If the PC is connected to an internal network, then *ALL* computers on the network are subject to security breaches. This configuration *is not* recommended without serious consideration of the implications.

For directory services, until X.500 is widely implemented, the Internet's Yellow Pages with Domain Names Services and Network Information Service will suffice as non-proprietary lookup services.

APPLICATION: ELECTRONIC MAIL (continued)

ELECTRONIC MAIL ENCLOSURES

Beware of electronic mail systems that only allow messages of memo size. Immediately after an electronic mail system is installed, a school will want to enclose word processing documents or spreadsheets with a mail message.

ELECTRONIC MAIL BUSINESS APPLICATIONS

Electronically enabled mail systems are emerging to exchange structured information between PCs and LANs, replacing traditional online applications. Some of the more creative ones for K-12 education are:

- transcript exchange
- state required forms
- student tracking
- environmental education
- curriculum cooperative development
- linking K-12 students with various news sources
- pen pals
- Electronic Individual Electronic Plan (IEP)

By using existing PC applications and data bases connected with electronic mail, the applications can be extended throughout the state.

Another approach to electronic mail is wireless electronic mail sent through paging or cellular networks. The wireless networks can be effectively hooked to electronic mail systems. However, they

- generally have low bandwidth
- can handle only a paragraph or a page of data
- are subject to static between base stations
- are usually available only in metropolitan areas

There are companies offering electronic mail connections to voice actuated response units in which the memo is translated to voice and back. These systems can be cost effective when a voice mail system is being considered.

APPLICATION: ELECTRONIC CONFERENCING

BACKGROUND

Electronic conferencing has emerged as a way to communicate in groups organized around a subject. If electronic groups participate simultaneously, it is known as a "chat" session. Feedback is posted by messaging or composing electronic mail. The Internet NEWS GROUPS have comprehensive conferences worldwide. The information can be downloaded to a particular machine or accessed interactively.

An example is the Maricopa Community College District's **Electronic Forum.** It is a local electronic conferencing system with downloaded NEWS GROUPS.

STANDARDS

The de facto standard for conferencing is patterned after the Internet NEWS GROUPS. This is due to the sheer number of computers and people worldwide who participate.

RECOMMENDATION

Standardize on a system for conferencing compatible with the Internet NEWS GROUPS. Dissimilar conferencing systems will not work together.

APPLICATION: FILE TRANSFER

BACKGROUND

File transfer between computers is usually a result of an application or person needing data from another machine. File transfers can have many data components, including voice and video, if the applications at either end can handle it. File transfer can be viewed as a superset of electronic mail. Standards for content and format of files can be developed and used in applications having file transfer capabilities. File transfer was traditionally handled by remote job entry devices on mainframes. Now the network acts as a catalyst and is not limited to formats which can only be printed.

Because files are not memos, the sizes can be very large, especially if graphics or video are used. One 30-frame video clip can use a gigabyte of storage with no problem. Most networks can't handle large volumes of data cost effectively. Motion Pictures Expert Group (MPEG) compression to compress full motion video is available on some workstations and PCs but it must be available also on the receiving device. A cooperative effort involving K-12 schools with the state, universities and colleges will be required to have a network capable of video file transmission.

STANDARDS

Most computer manufacturers have their own proprietary version of file transfer protocols, and most, unlike computers, can't exchange files without conversions and equipment. The de facto standard for Internet is File Transfer Protocol (FTP) . The Open Systems Institute (OSI) standard for file transfer is File Transfer Access Method (FTAM). Computer manufacturers who have standardized on FTAM and skipped FTP are now retro-fitting.

RECOMMENDATION

Standardize to the Internet by using FTP for file transfer. FTP and TCP/IP require the UNiX operating system or some implementation on a computer simulating the FTP and TCP/IP software. It may make sense for a school to forward files to an intermediary computer having the FTP protocol to connect to the Internet.

APPLICATION: INFORMATION SERVICES

BACKGROUND

This topic excludes network standards for information pertinent to local schools only and focuses on information more public in nature. Information services depend on useful information being available online from sites willing to share.

The Phoenix Newspapers and CNN have electronic information files available for schools for downloading to online services. Research has shown that schools are more interested in being able to search information repositories by topic rather than just to view today's news.

Ed Krol, author of *The Whole Internet* explains how information searches take place on the Internet:

> "WAIS is a client/server system, with the client portion being software that runs on your computer and lets you formulate questions to be asked of various sources. The server portion consists of databases offered on several servers throughout the Internet. When you do a query, your client contacts each server you specify in the search and matches the words in the question against words in an index built especially for this purpose. It returns the titles of items that match the question you posed. After displaying the titles, WAIS lets you choose to retrieve any number of them, and will display the items or send them in a file. Servers typically contain a collection of textual files and an accompanying index of key words. Since the search is done using an index rather than the actual file type, retrievals can consist of any file type, including graphics. There are multitude of sources for public resource listings."

The information sources are indexed text based, operating much like word processing documents. These are *NOT* data bases typically written about in trade journals like *SQL, Object Oriented, Hierarchical*, etc. They are simpler to use and access, and within the possibilities of schools and school librarians who already conduct these types of searches.

STANDARDS

The de facto standard is again set by the Internet global community and consistent with online providers: text based with index searches using client/server architecture. The international data base standards are SQL based with client/server architectures managing the access.

RECOMMENDATION

Since the international standards deal with more complex data base issues down to the element level, it would be beyond most K-12 schools abilities to manage them. The simple text with index based on client/server is the recommended choice maintaining consistency with the tools emerging and adopted by the Internet information servers. WAIS, WWW, and GOPHER could be an applications server accessible by K-12 schools via a network for searches across the Internet. It is important that K-12 school librarians be involved in this project.

APPLICATION: DATA TYPES

BACKGROUND

Data types are important for network design because most data types are ignored by most designs as being too complicated or too large. The applications that generate the data must be able to send and receive common data types for the data type to be usable. Some applications are known to handle many different data type variations. For example, Adobe Photoshop has the ability to handle graphics files from almost any package *The key aspect of data types is that the computers and applications at either end of the transmission must handle those data types.*

The data types for network transmission in order of usage and complexity are

- Text, ASCII or EBCDIC messages and files
- Binary or GRAPHICS files with and without color
- Compound Documents - a file containing a combination of text and graphics usually produced by a desktop publishing package as a prepress document
- Voice files containing voice sound waves
- Video images, both still frames and full motion

The key to analyzing data types is to recognize the ability or inability of the devices which send and receive the data. Virtually all personal computers handle text and most now handle graphics files. Some older mainframe and minicomputers may not be able to handle text files if they haven't been programmed to do so. Few applications exist to use graphics files as a fundamental part. Only very specialized computers and applications handle video and voice.

STANDARDS

The de facto standard for text is ASCII. Most word processors have their own file formats but files may be saved as TEXT for transmitting to other locations.

Graphics images come in two types: bitmap and vector. Graphics files may use either one or both representations. Bitmap representations are grid points of pixels on a screen and may be called TIFF, GIF or TARGA. Vector representations are descriptions of images as series of lines or shapes, perhaps with some regions filled in with a solid or graded shapes or colors.[5] Bitmaps are used for photos, paintings and grabbed video screens. Vector formats are used for line art, CAD (Computer Aided Design) drawings, charts, graphs and illustrations. Color or monochrome are a function of the file's internal format but have significance in terms of size of files transmitted and cannot be ignored due to the proliferation of programs generating color images. Images sent though a fax or scanned in are typically bitmapped.

Compound documents are typically Computer Graphics Metafile (CGM) an ANSI/ISO (International Standards) standard and/or the de facto Postscript standard, a complex page description language with an extensive command vocabulary originally designed for printers and computer screens. Encapsulated Post Script (EPS) is used for handling graphics files.

In rare instances, voice files are used as enclosures for electronic mail. Most computers can't handle voice files. Many applications for K-12 have voice components but are typically confined to one computer.

Video computers and applications are starting to appear even on inexpensive computers. The Quicktime™ component of Apple Computer's offerings is causing educational applications to emerge. Prior to Quicktime™, the primary media have been Laserdisks, CD-ROMs and VCR outputs. Quicktime files are starting to appear in networks and applications.

The Internet MIME standard for electronic multimedia mail message enclosures has been adopted by some mail systems. This standard allows the transmission of non-text data types across computers that may not be able to process multimedia data, e.g. every computer in the link need not be multimedia literate.

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[5] Graphics File Formats, P. 3

APPLICATION: DATA FILES (continued)

RECOMMENDATION
Plan for all file types when creating the network topology. Implement electronic mail with MIME enclosures so when the computer devices and bandwidth requirements catch up, the files can be utilized at either end by those computers capable of multimedia.

Compression becomes important for all files larger than TEXT and can be accomplished on computers creating and saving the data. By all means, use compression before the files are sent as electronic mail enclosures to reduce the bandwidth requirements.

APPLICATION: VIDEO CONFERENCING

BACKGROUND

Video conferencing allows participants to communicate face-to-face and exchange information. The technology which is used varies. The discussion which follows provides some examples of existing video conferencing capabilities within the state.

Northland Pioneer College serves a large geographical area (21,000 square miles) and depends on radio and video links for distance learning. The college's network, Eagle-net, is made up of two independent and separate distance learning delivery systems. One is a live interactive audio teleconference system, the other is a live interactive video teleconference system. The audio system links a total of 10 campuses while the video system links six campuses and plans to add two more campuses in the near future. Both systems are connected to six of the college's campuses via college-owned and operated microwave radios. These radios carry the two teleconference systems and all of the college's data and intra-campus communications. Northland is in the process of linking to the Northern Arizona University (NAU), Arizona State University (ASU) and University of Arizona (U of A) video backbone to provide comprehensive, inter-networking strategies for video.

NAU uses analog microwave links for video, voice and data. Land lines were impractical in adjacent terrain and in many cases cost prohibitive. NAU has three electronic classrooms designed to handle two-way video sessions between two or more interactive sites simultaneously. Full-motion video conferencing is available on NAUNet between NAU and NAUNet Affiliates. Origination of broadcast-quality satellite participation in state, regional or national video conferences is also available.

The Arizona Department of Education has established a video conferencing center in the Arizona Supreme Court Building in conjunction with NAUNet. The system allows for satellite, microwave and compressed video (codec) transmission.

Public video (codec) conferencing rooms are available from commercial providers in some major metropolitan areas. Private video conferencing rooms may be made available from large Arizona private entities.

STANDARDS

The industry standard for video (codec) at lower speed lines is Px64 which requires a 56kb line going in each direction, or two 56kb lines at a minimum to reduce tiling and slow motion transmits. Before the px64 standard was available, proprietary equipment requiring T-1 links was the norm. Ideally T-1 circuits are preferred.

RECOMMENDATION

The codec equipment needed at each end to compress/decompress the video frames may be prohibitively expensive. Video to the desktop is being offered by some vendors, including the attachment to a phone. However, the network costs and infrastructure are not in place to support the usage on a large scale. Proprietary codecs should be avoided because they generally will not "talk" to other vendor's equipment. Choose equipment that uses the Px64 standard or team with a community college, university or company that has the compressed video cabability. Renting public rooms from various commercial providers is another option.

Public switched (dialup) video conferencing links are available in fractional T-1 increments. The participating parties need only have the CSU/DSU equipment at each end.

CABLE AND PLANT

GENERAL BACKGROUND

Cabling, done poorly, can cause the best of networks to fail. Cable issues are typically handled at the local K-12 level but can have implications everywhere else in an interconnected network.

The number, type and location of computers and the applications they support are fundamental to choosing a cabling and local area network scheme.

The simplest of cases is two PCs close together with perhaps a printer to share. This may require only a switch box, called an A/B switch. The downside is that the printer has to be switched physically for each printout change and print files can't be queued up for printing.

The next step is to use existing phone wire and low-cost connectors in daisy chain fashion. Printers and files can be shared and, with software additions, print files can be queued.

Low-level peer-to-peer networks using Lantastic, for example, have become popular because they don't require dedicated servers. Ethernet and Token Ring require special cards to be installed on the PCs/MACs. An alternative is to buy a separate device that connects to both the network and the parallel or SCSI port.

Some common cabling terminology used is

- 10 Base-2 - a bundle of small cables in one large cable package
- 10 Base-5 - coaxial (thick, heavy) cable with no intelligence
- 10 Base-t - runs on phone cable or four conductor, unshielded twisted pair cable, requires a hub which can intelligently monitor and manage the network.

A hub is a central device in the star topology that directs the signals from one node to the next. While a hub is more costly to start, cost savings occur when the first move occurs. Hubs can support four to 24 devices.

EXISTING BUILDINGS BACKGROUND

The first step is to find if cable exists from as-built drawings, walk-throughs; or surveying existing cables, where they run, and determine their quality. The location of wire, where it is spliced and what is connected to it must be understood. Cable distances are important so that appropriate repeater devices may be installed.

Line quality becomes important to a network because it is able to transport at high speeds. Slow network protocols like AppleTalk mask the speed issues, but Ethernet and Token-Ring require better quality transmission.

EXISTING BUILDING STANDARDS

The proper type of wire is rated by UL at the corresponding data rates:

- Level 1 for data rates below or equal to 200 kilabites per second (kbps)
- Level 2 for 4 megabits (mgb) per second
- Level 3 for 20 Mbps and slower (standard Ethernet)
- Levels 4 and 5 (speeds up to 200 Mbps

The phone jacks must match the level. All jacks should be equipped with RJ-45 connectors to ensure that different network topologies can be run for voice, fax, and computer access without redoing the entire cabling scheme. For example, LocalTalk requires two wires (one pair), Ethernet requires four wires (two pairs), and voice/fax/modem lines require two wires (one pair). Some schools make it a practice to install four or six-pair wiring in anticipation of multiple use, including video to the desk.

Even in old buildings with no construction changes, network installation can be done in parallel with existing networks. Replace aging phone wire, create zones and start using naming conventions in the new areas. A PC/MAC dedicated to sharing files or electronic mail may become necessary as the number of nodes increases.

When simple networks become saturated and start to degrade (printing slows down, computers crash and some computer functions become noticeably slower), the use of high speed backbones and routers may be required. Traffic isolation may be required to handle image or desktop publishing files.

Ethernet is the next level of upgrade in wiring and usually resides as a backbone. Clusters of workstations may be connected through a server or bridge or each PC/MAC can be directly connected.

A high performance server may be necessary. Existing servers may need to have memory upgrades and will usually need more disk space. Servers should run on the highest performance computer engine affordable to yield maximum performance. Large networks (50 nodes or more) may need a network operating system like Netware and will require some dedicated local support to keep operational.

RECOMMENDATION FOR EXISTING BUILDINGS

Ensure that there are no electrical grounding problems by having electrical contractors run tests.

After the existing cables are mapped, a plan for additions must be drawn up. Some buildings are so old they can't easily adapt to new technologies, so vendors should do walk-throughs and recommendations when the expansion plans are being drawn up.

Identify all potential work areas and all applications and devices with which they must connect. Next, do the topology and make the technical decisions.

It's very important to include data cable plans in all moves, changes or additions to buildings. Data cables may be laid at the same time as phone cables with little additional cost even if a computer does not exist in the work area. It's far more expensive to go back and re-cable. If a cabling scheme has been standardized, then stick with it unless this is a major innovation. Make network plans for upgrading to higher-speed cabling devices in sections (clusters of workstations) and test all network topologies on a small scale before rolling out the entire plan.

NEW BUILDING BACKGROUND

There are a plethora of cabling options for new buildings to make them "smart" buildings. Devices exist to run data over electrical wire via wireless devices, the traditional phone wire and coaxial cable. Even though network wiring is usually an unanticipated cost (except for voice), it is by far cheaper to include when a building is being built rather than retrofitting it later.

Decisions have to be made on topologies to know where and how to string the wire. When a building is being designed, meet often with the architect, contractors, vendors, local phone companies and wire providers to ensure computer and network compliance. Nobody but computer people will look out for this aspect and most other vendors will not be conversant in data and video networking needs.

ELECTRICAL RECOMMENDATION

Ensure enough power is available for computer devices. Some servers require more power than may exist in the plan. Add up the KVA for all devices to ensure that the UPS systems can handle the load. UPS systems are inexpensive; they should be included in the design. Losing a couple of PCs gets to be more expensive than having UPS protection for all computer devices. Design isolated breakers and provide grounding through a separate switch to each location, with orange face plates solely for computer plug-ins.

PHONE/DATA CLOSET RECOMMENDATION

In modern cabling schemes, phone closets for data are necessary and can coexist with phone switches. All lines will route back to the phone closets, so it is sensible to have multiple closets for buildings of any size and beyond one story. The phone closets should be large enough for technicians to work in. Phone closets are potentially the areas of greatest breech of security. A network diagnostic station may be required to be housed in the closet.

BACKBONE RECOMMENDATION

Run both fiber and copper backbone through the building; copper for now, fiber for later. The connections for fiber may be prohibitively expensive now but will be welcome when prices drop and equipment is outfitted with fiber.

CABLING RECOMMENDATION

Avoid coaxial cable even though it may appear to be the cheapest, except between buildings. It becomes more expensive with any move occuring in the building. Clustered thin-net or twisted pair hubbed through concentrators and delivered to each anticipated work area is a good approach. Fiber is still too expensive to deliver to each workstation. Each workstation should be equipped with 4-6 outlets. Look at wireless Ethernet for delivery to areas where large re-configuration is anticipated. Put shielded (teflon) cable where cable runs through the ceiling area per building codes.

DIAGNOSTICS RECOMMENDATION

Purchase or rent tools allowing the ability to look at the cable runs and tell if they are broken or not and where. Test the runs all the way from a PC to the outside world. Expect the wiring vendor to provide a complete drawing of the building layout, and expect that the K-12 school must be responsible for keeping it up to date. Each area must be tested with a live device (PC/MAC) with some printing tests. The cable vendor should ensure that all wiring anomalies are removed before the job is done.

ETHERNET WIRING PROTOCOL RECOMMENDATION

Select Ethernet as the basic wiring protocol. Conversions including extra equipment must be made otherwise, to link to outside networks. Virtually all vendors support Ethernet. For networks of any size, use cable concentrators to minimize cable distances and rework.

Avoid specialty cables and proprietary wiring schemes. They are usually more expensive to install and much more expensive to support.

INTERNETWORKING

BACKGROUND

Some of the basic components to internetworking are included in the glossary. A typical internetwork involving dissimilar LANs and computing devices would use a hierarchical backbone approach where series of backbones are linked to a private/public router for outside connectivity.

Routers handle addressing, masking, diagnostics, naming and traffic control. They also handle multiple-protocols. Most K-12 schools have a mixture of equipment and may want to share files or conduct electronic mail among them.

The New England Academic and Research Network (NEARN), which links hundreds of New England universities and organizations to the Internet, uses only one brand of router. "We would love to run more than one type of router, but we're in the business of network operations, and fiddling with different routers would be a big problem for us." says John Rugo, business manager of NEARNet. "About half of the regional networks that make up the Internet run on a single brand of router. The router-to-router interoperability problem occurs mainly in wide area networks, not LANs, according to Scott Bradner, a consultant with Harvard University's Office of Information Technology. That's because encapsulation protocols for sending data across a LAN are well established, he says.[6]

RECOMMENDATION

Standardize on routers within a particular district and ensure the routers can link to the statewide networks externally with Ethernet. The routers at the next level beyond the schools (the county or region) and the statewide gateways should be the same. Today's routing protocols don't necessarily route the same and have different requirements and management techniques.

INTERNETWORKING TO WIRELESS DEVICES BACKGROUND

Electronic mail and other PC-LAN-WAN applications are being extended to people on the move. RAM MOBILE has a device to send and receive electronic mail to the H/P handheld device. Apple's spinoff, General Magic, and others are announcing personal communicators using TeleScript messaging software and Magic Cap for operating pen computers and telephones. Small alphanumeric messages have been available on pagers for some time.

Communications Week reports[7]:

> "The Cellular Digital Packet Data group, recognizing that its network must look more like a traditional data network, has decided to go back to the drawing board with the specification it will use to send data over cellular networks. In the next few weeks, the group will reveal the specification, which is built around traditional data communications specs. It abandoned a "telephony-based architecture" because it would have required too much development by vendors. The group's network will initially support the Internet Protocol—familiar to many users—and the Open Systems Interconnectional Connectionless Network Protocol"

Modems are being built to handle high speed dial-up for data, cellular and fax.

The question becomes when to intersect to wireless devices. The industry seems to be heading into a direction not purely voice-based while at the same time voice systems are offering a plethora of systems like voice mail, voice fax-back, voice actuated response, etc.

The RBOC's culture is heavily voice- and wire-based although they handle data and wireless through a myriad of alliances. Computer and networking companies use their considerable creativity to bring out new devices yielding new services. The device that automatically programs VCRs to the current *TV Guide* listings is an example of niche creativity in cable and broadcast delivery.

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[6] Higgins, Kelly Jackson. "The Best Path? In the often-rough terrain of internetworks, some users would rather rely on routers from a single vendor than risk interoperability snags." *Communications Week*, March 22, 1993, P.53

[7] Roeckl, Chris. *Communications Week*, March 8, 1993

INTERNETWORKING (continued)

The cable companies are aggressively laying two-way fiber (send and respond) to K-12 schools nationwide and expect to play a large role in information highway projects. A recent announcement linking Microsoft Windows with an Intel 486 device for TVs could be the information device to manage multiple channels of programs.

Mixed and multimedia applications are in their infancy for data crossovers to video.

Persoft's Intersect Remote Bridge offers a high-performance, wireless bridge that connects physically remote LANs up to three miles apart using spread spectrum radio technology. Using wireless at two Megabytes per second versus a T-1 circuit is less expensive, has no recurring costs, needs no government approvals and has no cabling costs.

Solectek Corp. has begun shipping three wireless LAN products: a bridge connecting buildings up to three miles apart, an adapter for Ethernet LANs and a concentrator that can integrate multiple LAN topologies.

STANDARDS FOR WIRELESS/MULTIMEDIA/ INTERNETWORKING

The standards for confluent technologies have not yet been adopted for any significant usage. Some services act as protocol converters from one technology to the next. Emerging standards for hand-held devices may drive standards for roving devices to computers, but it's too early to tell.

RECOMMENDATION FOR WIRELESS/MULTIMEDIA/ INTERNETWORKING

If the assumption is that data being sent across information highways will be ultimately mobile, then the standards and architecture should be data information based. Much development for voice-data translations is being done with primitive devices starting to appear. Voice will be considered an input/ output device. Even though the "wires" carry both, predominantly in mixed mode, the view should be from data outward.

A small data-to-wireless test project might be sponsored by a company and service that support these devices. However, it should not be the primary focus of standards in K-12 networking.

FUTURE NETWORKS

BACKGROUND

Future networks are defined in this study as being more than a year or two from availability in Arizona and whose market acceptance is unclear.

For example, Communications Week has said[8]:

> "ATM—a cell-switching technique capable of transmitting voice, data and images at megabit and gigabit speeds—has been a favored child of many industry experts, enjoying predictions of success before ATM-based products were ever available. Last year, the first of these products were rolled out, but few users bought them. For most, the products were too expensive and offered far more throughput than most users needed. Experts agree that ATM prices will drop and users' bandwidth requirements will rise. In the meantime, vendors of other technologies are scurrying to position their products as alternatives to ATM for local and campus networking. Two weeks ago, H/P, IBM and Sun Microsystems formed a partnership to promote products based on Fibre Channel specifications. Fibre Channel carries bulk data, video and voice over "nailed up" circuits and packet data over connectionless circuits. And last week IBM, National Semiconductor and others approached the IEEE about creating a standard for Isochronous Ethernet which would make it possible to transmit voice and video over Ethernet LANs. Among other high-speed technologies aimed at local and campus networks are the Fiber Distributed Data Interface, FDDE-over-Copper and so called "Fast Ethernet." These technologies are not as well suited for multimedia as ATM, but then, few companies seem to be deploying multimedia applications. It is clear that the precocious ATM standard has graduated into a world of stiff competition. We feel it is comfortable saying that ATM's chances of acceptance are high, especially in wide area networks. But users should avoid being too awestruck by ATM. There are and will be plenty of good options available."

RECOMMENDATIONS

While new technologies can be seductive, it is generally better to get the basics done first. If K-12 schools standardize on network strategies and equipment and get support from colleges and universities, they have the enviable position of participating in technology plans and experiments. Individually, most schools would have little impact on future networks unless they are a part of a very large district.

When individual K-12 schools have to negotiate with vendors for network solutions, they may get one solely based on voice. Conducting symposia to keep up with network futures is a suggestion. Electronic conferences on specific topics could also contribute to information exchange between K-12 schools.

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[8] Editorial, "Many Roads to High-Speed Connections," *Communications Week*, March 8, 1993

NETWORK STORAGE MEDIA

BACKGROUND

Shipping networked files can require some special solutions. Magnetic media purchased for a PC/MAC at the outset quickly become consumable.

Some new storage media are becoming viable for network access:

- CD-ROM collections with CD readers (read only)
- Optical platters
- Re-writable optical recording media
- Magnetic disk

The issue for network access is performance and storage capacity. Accessing data across the network from a slow-access device can make the information unusable. Large image file transfers can also be tedious.

The best solution is to have magnetic media available with re-writable optical for files, only occasionally accessed. CD-ROM access can be very slow even on a machine with no network. CD collections may be downloaded to magnetic disks with the author's permission. Different CD-ROM collections have differing access software, which makes searches confusing.

Some optical devices are now approaching magnetic media speeds and have much more capacity. Giant optical "jukebox" arrangements are being used for large collections of data.

The key is to tier data in order of usage: most used on magnetic, sometimes used on optical, and backup on optical or tape while not requiring staff to mount tapes or change platters.

RECOMMENDATION

The cost of magnetic media, Write Once Read Many (WORM), optical and CD-ROM's are dropping. For network access, buy only in gigabyte increments and prepare to add more devices. Ensure that the server has enough memory and speed to handle file traffic. Standardize on a search engine if possible. Use the file systems optical or tape media for backups at night.

NETWORK FINANCIAL CONSIDERATIONS

The cost of the network is dependent upon

- what approach is taken and the associated costs
- what application(s) are selected
- scope and direction of first funded project
- level of support required
- interconnectivity desired
- level of service
- vendor selection for network, hardware and software
- long term goals

The financial issues associated with the provisioning of a network require much more indepth discussion than allocated within this document. While simple comparisons may be made between competitive goods or services, the total financial scope may not be determined until a long-term network strategy is both identified and quantified. One of the many risks that the K-12 community and other public education institutions take is proceeding with components of their networks prior to the identification of their issues of interconnectivity, management and applications.

Implications to the development of a network, particularly when dealing with a statewide network, exist both from the top down as well as the bottom up. Needless to say, the decisions that Arizona state government and the universities make over the next five years will affect the networking capabilities of the K-12 community. Concurrently, any plans and procurements made by the K-12 community will affect the capability of the large entities in achieving "last mile" connectivity.

ARIZONA EDUCATIONAL AND INFORMATIONAL TELECOMMUNICATIONS COOPERATIVE

The Arizona Educational and Informational Telecommunications Cooperative (AEITC) is dedicated to encouraging and advancing cooperative planning and development of educational telecommunications in the state of Arizona. Formed in the summer of 1988 by representatives from public universities, community colleges, the K-12 system and the state Department of Administration, the AEITC provides a forum for sharing information about educational telecommunications' activities and technologies. Members have a common interest in exploring ways in which institutions can work together to develop systems and services that will meet educational needs throughout the state.

As telecommunications technologies have advanced, the use of electronic educational tools - video, audio and data - has grown considerably in Arizona. Consequently, distance from educational resources is no longer a real obstacle to making use of those resources. The obstacle that still exists is the inconsistency of technology and connectability to the resources. The Arizona Educational Informational Telecommunications Cooperative hired Evergreen Communications to develop an effective and concise information packet for Arizona's public education institutions to use as a tool in the development of their institutions' local and wide-area voice and data telecommunications solutions.

Until the formation of the AEITC, there was no structure to foster cooperation among institutions. The variety of services available in the state has lacked widespread coordination and ready accessibility. Educational telecommunications services have been more available in metropolitan areas than in rural Arizona, more typically used in business than by the general public, and more responsive to market trends and isolated decisions than to the rigorous demands of a long-term, statewide development plan.

Recognizing the benefits to be derived from a coordinated approach to the growth of educational telecommunications in Arizona, the AEITC has defined its goals and objectives:

GOALS:

1. Provide a forum for highlighting key telecommunications public policy issues and represent education's perspective to regulatory, legislative and executive branches of government.
2. Create a forum for dialogue concerning the requirements of the education community, technologies appropriate to respond to these requirements, economic and technical issues, techniques for applying technologies, and other matters of common concern.
3. Assist with the planning and development of coordinated policies by state educational institutions, boards, accrediting agencies, state agencies and the state executive and legislative branches to affirmatively guide the use of telecommunications for instructional purposes.
4. Provide assistance with the development and utilization of telecommunications delivery systems to improve the quality of opportunity and access to public educational services to unserved and underserved citizens of the state.
5. Encourage individual educational entities to develop and staff internal telecommunications planning, development and utilization units which can assist administrators, faculty and students in the integration of appropriate technologies.
6. Encourage the planning and development of instructional courses and related services which benefit from the applications of telecommunication technologies.
7. Facilitate appropriate, common technical and operating standards for telecommunications technologies and service levels to facilitate interconnectability of institutions.
8. Facilitate partnerships with the private sector to promote the delivery of education and training through technology.
9. Explore the opportunity of developing a division of the

AEITC to operate as a non-profit organization (RIS 501 c [3]).

For the Arizona Educational Informational Telecommunications Cooperative to meet its goals, the following objectives need to be met:

1. Establish a liaison with representatives of the state Corporation Commission, the state Legislature, and the Arizona Governor's Office to facilitate immediate access to each entity, as required, to promote and represent the issues with which the AEITC is involved. The AEITC will provide comment to all initiatives and represent unserved and underserved interests in all areas of education, delivery and access, as appropriate.

   Conduct quarterly meetings with all entities associated with the AEITC who hold an interest in topics being considered by the regulatory, legislative, or executive branches of government to discuss cooperative representation on these issues. These forums also should identify issues which the AEITC should bring forward in each fiscal year and legislative session for consideration by the AEITC Operating Committee and Board of Directors.

2. Maintain an annual schedule of statewide dialogue for each segment of public education represented in the AEITC — K-12, community colleges and universities— to share information in areas of common concern. Additionally, an annual conference will be held to accommodate the sharing of information between the segments and to external entities concerned with the progress of AEITC and its constituencies.

3. Act as a clearinghouse for all institutions, boards and agencies that are involved with issues which directly or indirectly affect the use of technology for instructional purposes. An active roster of such groups will be maintained by the AEITC from both a state perspective and national perspective. It is the responsibility of AEITC to maintain a relationship with these groups to publicly comment on all actions taken which affect education. A monthly update will be made available to the active roster of pending issues, initiatives, positions and results.

4. The AEITC will encourage and serve as a resource to assist each segment of public education within Arizona to prioritize the cooperative's needs, capabilities, expenditures and planning as it relates to providing equal educational access to all citizens of the state. Emphasis will be placed on supporting underserved and unserved citizens of Arizona.

5. Assist each segment of public education with proposals for continued development of telecommunications-related staff and facilities, whether they be internal or pooled resources based on economic availability of resources. Particular attention will be paid to the K-12 segment by playing an active role with the Department of Education in statewide planning efforts.

6. Provide administrative and technical resources towards the development of instructional coursework to be provided through nontraditional means, e.g., interactive video, correspondence tapes. The AEITC will act as a clearinghouse to maintain a database and disseminate information regarding activities such as the provisioning of training for faculty development and information on curriculum development. A report of these activities will be presented at the annual AEITC conference.

7. The AEITC will act as an agent for facilitating the interconnectivity of all member institutions. The organization also will represent these interests to external interest groups and public updates of interconnectivity to its members and work with interested parties to utilize such connections to enhance the delivery of education of their administrative requirements.

8. The AEITC members will act as spokespersons to the private sector to represent our mission and goals within the community. The AEITC will also foster and promote public/private sector partnerships through partnership agreements. A semiannual

presentation shall be made by the AEITC Operating Committee and Board of Directors to all partnership entities on the progress of these interests.

9. The AEITC will continue to investigate the opportunities behind establishing separate entities of the AEITC to be operated by a nonprofit organization. A business and marketing plan will be submitted to the AEITC Operating Committee for consideration and vote during the 1992-1993 fiscal year.

The networks that have been derived from a coordinated effort by the members of the Arizona Educational and Informational Telecommunications Cooperative to the growth of all telecommunications in Arizona are extensive. The members of the cooperative have worked hard to combine their institutions' individual resources for the betterment of the whole state's voice, video and data interconnectivity. The following maps are a few illustrations of the networks that are currently in place. All of Arizona's telecommunication networks are continuing to grow and to link rural communities into the mainstreams of technology.

If you have any questions or comments please forward them to

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ARIZONA LIBRARIES

BACKGROUND

Arizona libraries have been preparing for the "Information Highway" in several ways. The Arizona Department of Library, Archives and Public Library (DLAPR) sponsored the Arizona Pre-White House Conference in January 1991 to start the vision and planning process for library futures.[9]

Under the category of building relationships, sub-category Networks and Library Operations, the following recommendations were made:

- Clarify library goals, objectives and responsibilities.
- Develop formal ties between the Arizona Department of Library, Archives and Public Records and the Arizona Department of Education for cooperative leadership in the area of services, consultations and information technology.
- Identify and support networks already in place.
- Develop telecommunications networks and improve document delivery systems.
- Develop and support demonstration projects for networking at the local, state or county level and for cooperation among state agencies.
- Develop countrywide networks in addition to state level ones.
- Develop cooperative ventures among school and public libraries.
- Assure full professional staffing at all libraries and recruit and train volunteers to supplement professional staff.
- Utilize community information resources such as legal, medical, business or corporate libraries.

Under the technology section, the following recommendations were made:

- Establish standards for the automation and networking of libraries in the state.
- Provide strong support for the concept of telecommunications "highways" for data links among all types and sizes of educational and research agencies. This is specifically outlined in the proposal for a National Research and Educational Network (NREN), but expanded to include all research centers and libraries: public, school, academic, governmental and community.

DLAPR and the Information/Telecommunications/Database Subcommittee of the Statewide Resource Sharing Committee has printed "On-line in Arizona: A Directory of Library Dial Access Services."[10]

There was little demand for a dial access directory before 1991: too few dial access services existed to establish the need. But in 1991 Arizona saw the beginnings of an explosion in on-line services.

Following the early lead of Arizona State University, several other libraries implemented their on-line catalogs for the first time, and/or added dial access to existing on-line catalogs. The beginnings of library networks also emerged, the largest including the American Graduate School of International Management, Arizona State University (ASU), ASU-West, Maricopa Community College District (MCCCD) and Northern Arizona University (NAU). This network, in turn, is connected to a larger network that includes a myriad of out-of-state resources.

During 1991, another trend emerged, the concern for reducing costs by sharing expensive commercial databases by several network members.

DLAPR has since sponsored AZNET (The Arizona Network), (See Appendix F) an Arizona dial-in network service connected to the OCLC/AMIGOS Libraries to establish a statewide database and to facilitate inter-library loans in May 1992. An electronic message is built for a particular book identifying the libraries containing the book, and an inter-library loan request is generated, greatly simplifying the process for sharing book resources and widening the accessibility of books. This system is available to subscribers in K-12 school libraries provided they are willing to loan as well as receive books.

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[9] Morrison Institute, "Beyond Tradition: Report of the Arizona Pre-White House Conference on Library and Information Services" January 1991

[10] Kneedler, William H and Biles, Jami L., State of Arizona, *"Online in Arizona: A Directory of Library Dial Access Services." 1992*

The East Valley of Maricopa County formed a consortium consisting of libraries, including public, community college and secondary schools and built a network, called EVIN (East Valley Information Network) to provide access to member libraries' holdings via a CD-ROM union catalog and interlibrary loan. In its second year of operation, the demand has been significant.

The Maricopa County Libraries through the Cooperative Association for Library Communication have been involved in technology projects including EVIN and prototyped Evergreen Communications' LIBRE electronic mail system.

Other libraries with on-line offerings are Phoenix Public, Pima Community College, Scottsdale Public, Tempe Public, University of Arizona Health Services, Chandler Public, Glendale Public, Northland Pioneer College and Tucson Public.

The University of Colorado has the CARL system for linking library collections together electronically with interlibrary loans available via Colleges and Universities. The CARL system has extensive search characteristics. Text-based electronic collections are becoming available to libraries throughout the world, spurred by the goal of tying them all together.

The ERIC Clearinghouse for Educational Informational is on-line via the Internet, previously available via paper and microfiche.

LIBRARY INDUSTRY STANDARDS

The international standard for library network access is the Internet. Some regional libraries such as the OCLC have proprietary access with specific standards and protocols. They are not mutually exclusive and intersect at various points through Universities and Colleges.

Collections for libraries are increasingly in digital rather than paper form providing immense possibilities for library online access. Most collections are emerging as CD-ROM based which are not necessarily accessible on-line. CD-ROM collections have proprietary search software, largely incompatible. Technology and usage will overcome the CD-ROM limitations (access time on networks and licensing). Other text-based collections are emerging on networked systems. Librarians have unique ways to search online collections, which drive the interest in Gopher, WAIS and WWW services across the Internet.

LIBRARY RECOMMENDATION

The K-12 schools are disadvantaged in the on-line library world. Commercial data base usage is typically too expensive and too cryptic to use. School libraries/media centers should be the first area online for any network access. Many schools do not have phone lines to the libraries or have to share in modems and lines, which challenges dialup access on an ongoing basis.

Because of the search patterns using software and networks by librarians, it is critical they have a modem and dialup line at a minimum. A batch download of news groups and conferencing will not suffice and will further disadvantage K-12 libraries from interconnecting with peer librarians in any way except through electronic mail.

K-12 schools should closely cooperate in any networking plans, events and strategies with the idea of linking into the closest Internet link adopting Internet network standards and search software.

There are numerous strategies available to move forward with the concept of setting or recommending standards in the communications and data connectivity arena. Given the political nature of the public education sector and all of its diversities, a path of collaboration is recommended which can neutralize these issues.

STUDY RECOMMENDATION

It is recommended that the Arizona Educational and Informational Telecommunications Cooperative focus on the following:

- training
- planning
- procurement (support)
- implementation (support)
- support of statewide networking and data connectivity

TRAINING

The diversity of the public education entities within Arizona can easily explain the immense need for training. The level of recognition of the issues discussed here runs the entire spectrum of advanced knowledge of internetworking issues all the way to understanding the local telephone company and services it provides.

It will be difficult to gain full support of the issues identified in this report unless five levels within the education system are addressed via training:

- teachers
- technicians
- administrators
- superintendents
- board members

Each level has a different degree of technological experience which affects whether or not a successful network can be implemented within a particular school district or community college. If teachers are not trained to use technology effectively they will continue to be a roadblock for students in their use of technology. Technicians can only be responsible for issues for which they are trained. The greatest risk a school may take in this area is allowing greater dependency on vendors of technology without clearly understanding the risk that it may present. Administrators carry a large responsibility in integrating the use of technology into the school district and the classroom. This group is usually solely responsible for the procurement procedures followed when contracting for technology-related hardware or services. How can a purchasing department be held accountable for bidding technology contracts without any familiarity? The exposure to vendors is again great. Finally, superintendents control the allocation of monies to the various budgets within a district. Unless this group of individuals is sold on the concept of integrating technology into their environment they will continue to dilute monies which would be better spent on the deployment of technology within their districts. As is true regarding any issue, how can a group of individuals champion an issue if they cannot speak effectively to the issue?

Those who were interviewed during the development of this document identified a strong demand for such training and a desire for ongoing sessions. During a seminar providedby MCCCD on networking designed for K-12 schools, it became evident that the skill set of those attending was even less than initially anticipated.

The University of Arizona is also conducting inservice training for any K-12 teachers in Pima County who are interested in learning more about Internet connectivity and usage. A tremendous demand has also been realized through this project.

The Arizona Department of Education has conducted and continues to conduct a satellite-distributed teleconference series on networking. Video tapes and supporting materials are available to interested parties.

There are other attempts around the state to tackle the awareness level of technology within our schools. However, the demand easily seems to outweigh the availability of such services. The AEITC can play a valuable role in co-sponsoring these types of activities either through financial commitments or through the identification of private partnerships. Also, a directory of available services would be of tremendous value for individuals or schools looking for available training. The AEITC could also potentially recruit attendance at such seminars.

PLANNING

As repeated throughout this document, technology standards will be meaningless without proper planning. This planning, again, must come from both the bottom and the top layers.

At the top levels of Arizona public education, the planning process is nothing new nor is its value underestimated. An area which does require greater concentration becomes evident when assessing the interplay between public education and governments. It is undoubtably true that greater levels of cooperation would result in the maximization of networks and associated costs. This is not to underestimate the combined strength which would produce a stronger technology environment for the entire state.

The K-12 arena needs to rally amongst itself and continue to seek support from neighboring community colleges and universities. Problems vary within the K-12 schools relative to their location within the state. Greater value must be placed on the ability of educators within K-12 to communicate with each other in order to share experiences and assist in accessing information vital to the success of all schools. Regional forums have developed around the state but most areas are still in need of assistance from those who may have forged ahead. The school districts in the Tucson area appear to have bonded quite well and have a very effective communication process established.

The AEITC can be very helpful in more cohesively furthering the planning process than exists today. The AEITC has been a forum for dialogue between all three sectors of public education in Arizona. (It is an excellent platfrom in support of cooperative planning among universities, community colleges and K-12.) Additionally, the AEITC could assist in identifying a process which would enable school districts to become more competitive in dealing with technology issues. An advisory group such as the Tri-University group would be an excellent reference for school districts to attempt to gain access to answers from questions encountered at the school district level. Planning within the K-12 segment is most critical in dealing with "last mile" issues. The value of the information highway created in Arizona will be diminished by every school district which is unable to meet the standards of connectivity necessary to gain access into this highway. The mission of the AEITC to provide equal access and services across public education is a critical issue in the planning process.

PROCUREMENT

The procurement process within any public sector entity is tedious and cumbersome and allows for much exposure to the experienced vendor community.

The cost of administering the procurement process is tremendous. It is a cost which every school district bears. Every associated task and product is included in the procurement process when it comes to technology. From the inception of consulting services down to maintenance contracts, schools pay a considerable amount of money for both the process and the products and services which are retained.

There has recently been a greater focus on "term contract" bids and requests for proposals. This focus allows the procuring entity to purchase products or services over a predetermined period of time for a set price. These contracts many times also specify that "other political entities" may purchase these goods and services during the same time periods for the same costs. The term of these contracts may vary from one to three years. Contracts awarded from the largest of institutions or governments usually carry the best value in pricing from vendors, therefore creating a greater demand for the larger entities to include term provisions in their requests for proposal. This scenario equates to a win/win situation for both users and vendors when dealing in competitive pricing and quantity discounts.

Another very successful enterprise within Arizona is the Mohave Educational Services Cooperative (MESC), a Mohave County agency located in Kingman. This organization recognized the need for competitive purchasing primarily within the K-12 community and has established an ongoing procedure to conduct competitive bidding for term contracts managed by the organization. Any school district or political entity may purchase services from Mohave by simply having a purchasing contract in place between an institution's purchasing department and the MESC. School districts have saved thousands of dollars through this bulk purchasing method.

Various avenues exist for school districts to maximize their spending dollars. The AEITC can play an important role in this matter by acting as a clearinghouse for the various term contracts and purchasing associations around the state. A catalogue system of all term contracts would be invaluable to schools when trying to purchase hardware or software. Schools and the larger institutions should also look at retaining consulting services on term contracts thus precluding the need for each school district to bid for such contracts. Additionally, a relationship should be created with the state Procurment Office which could stimulate more requests and bids to be let with term provisions. The state Procurment Office organization should also be made more aware of some of the needs within the education sector in order to assist in its endeavors. Finally, the AEITC or some other organization within the state should consider maintaining the lead role for the negotiation of network contracts with both in-state and out-of-state providers. This arena is virtually untapped within the K-12 market in Arizona, inevitably requiring that this community absorb costs which could otherwise be precluded.

IMPLEMENTATION

None of the three areas mentioned can be successful without proper implementation planning and delivery. The implementation of technology is one of the most vital aspects of the process which will deliver internetworking capabilities to K-12 schools.

Schools must take a greater role in the implementation process whether it relates to hardware, software or network services. Involvement with the process will harbor a greater sense of responsibility in the delivery of services and allow for a greater degree of self-sufficiency on an ongoing basis. The sharing of these experiences will further enhance the capabilities of the entire K-12 community to accelerate its movement towards greater technological freedom.

There are no courses available to learn the implementation process, thus requiring a tremendous amount of hands-on theory in progress. The AEITC could very well assist this effort by mentoring those within their segments who have yet to experience this level of involvement. The educational institutions in Arizona have together experienced an incredible amount of learning in implementing technology into their environments. Collectively, this experience could stand up to most vendor support available to the K-12 community. Identification of and access to such mentoring could, again, play an invaluable role within the state. Technology industries around the world have identified this type of interaction to be beneficial to both themselves and their users, e.g., technology users groups. Arizona user groups set up across the segments of public education could service a great demand for technological expertise as it pertains to both implementation and all other phases of technological growth.

CONCLUSION

The creation of this document has been extremely interesting and educational to all who have been involved. Arizona and its public education sectors have many frontiers to cross and, in many cases, have not been vocal enough about their current capabilities and opportunities.

Having been without a concise statewide networking plan for both voice, data and video, many individual institutions have progressed tremendously well on their own and in collaboration with each other when possible. Technology will never be simple and there will rarely be just one answer to a question. Arizona institutions are becoming more focused on applications to drive networks. Greater independence from providers is also evident from most of the larger organizations. This, in and of itself, is or should be sending a strong message to the provider community. It will foster a closer relationship with those providers who view themselves as partners with public education and will continue to disadvantage those providers who refuse to leave their traditional approaches in lieu of technological freedom for public education.

This document was intended to assist the Arizona school district personnel with their involvement in technology-based solutions. It has also been an attempt to recognize additional resources which are available within Arizona to assist the K-12 community in meeting the challenges that technology brings to the table every day. The AEITC can continue to play a much stronger role in the "last mile" issues within Arizona through its strong focus on the K-12 community and libraries. It is evident that even with the incredible focus that our federal administration is placing on the information highway, it will continue to be the responsibility of the states to act as arteries for their "last mile" constituents.

GLOSSARY

GLOSSARY

address - data structure used to identify a unique entity, such as a particular process or network location

address resolution - method for resolving differences between computer addressing schemes.

adjacency - a relationship formed between selected neighboring routers and end nodes for the purpose of exchanging routing information based upon the use of a common media segment.

advanced hubs - connect multiple LAN types, routing, and sophisticated management. Some have switching features offering higher bandwidths.

agent - software that processes queries and returns replies on behalf of an application. In network management systems, agents reside in all managed devices and report the values of specified variables to management stations.

analog transmission - signal transmission, over wires or through the air, where information is conveyed through variation of some combination of signal amplitude, frequency, and phase.

ANSI - American National Standards Institute, coordinating body for voluntary standards groups within the US.

ATM - a cell switching technique capable of simultaneously handling voice, data, image and video transmission at multi-megabit speeds.

ASCII - American Standard Code for Information Interchange. An eight-bit code for character representation, including seven bits plus parity.

asynchronous transmission - operation of a network system wherein events occur without precise clocking, individual characters are usually encapsulated in control bits called start and stop bits designating the beginning and ending of characters.

backbone network - a network acting as a primary conduit for traffic that is often both sourced from, and destined for, other networks.

bandwidth - rated throughput capacity of a given network media or protocol.

BARRNet - The Bay Area Regional Research Network

baseband - characteristic of a network technology where only one carrier frequency is used (Ethernet is an example)

baud - a unit of signaling speed equal to the number of discrete conditions or signal events per second synonymous with bits per second if each signal event represents exactly one bit.

BERT - bit error rate tester

binary synchronous communication - a character oriented data link protocol for half-duplex applications (bisync)

bit error rate - percentage of transmitted bits received in error

BITNET - Because It's Time Network, low-speed academic network

bit rate - the speed at which bits are transmitted (bps).

bridges - connects and passes packets between two network segments, best suited for sending data over non-routable protocols, such as IBM's NetBIOS and Digital Equipment Corps Local Area Transport.

broadband - transmission system that multiplexes multiple independent signals onto one cable, any channel having bandwidth greater than voice-grade channel or a coaxial cable on which analog signaling is used.

broadcast - a message sent to all network destinations

broadcast storms - undesirable network event where many broadcasts are sent all at once, using substantial network bandwidth and, typically, causing network time-outs.

bus topology - linear LAN architecture in which transmissions from network stations propogate the length of the medium and are received by all other stations.

cable - a transmission medium of wires or optical fibers wrapped in a protective covers.

CCITT - Consultative Committee on International Telephony and Telegraphy.

cellular radio - a technology that uses radio transmissions to access the phone company network with service provided in a particular cell (area) by a low-power transmitter.

centrex - an improved A.T.&T. PBX that also includes direct inward dialing and automatic number identification of the calling PBS.

circuit - a communications link between two or more points.

circuit switching - switching system where a dedicated physical circuit path must exist between sender and receiver for the duration of the call.

client - a node or software program that requests services from a server.

client-server computing - term used to describe distributed processing (computing) network systems in which transaction responsibilities are divided into two parts: client (front end) and server (back end). Both terms (client and server) can be applied to both software programs or actual computing devices.

CMIP/CMIS - Common Management Information Protocol/Common Management Information Services. OSI network management protocol/service interface for managing heterogeneous networks.

CO - Central Office, local telephone company office which all local loops in a given area connect and in which circuit switching of subscriber lines occurs.

common carrier - a licensed, private utility company that supplies communication services to the public at regulated prices.

compression - running a data set through an algorithm that reduces the space/bandwidth required to store/transmit the data set.
concentrator - device that serves as the hub of a star-topology network or a device that contains multiple modules of network and internetwork equipment.
congestion - excessive network traffic.

connectionless - data transfer without the existence of a virtual circuit.

convergence - the ability of (and speed with which) a group of internetworking devices running a specific routing protocol agree on the internetwork's topology after a change in network topology.

converters - to consolidate traffic from IBM Systems Network Architecture networks with TCP/IP networks.

CPE - customer premises equipment, terminating equipment, such as terminals, phones and modems, supplied by the phone company, installed at customer sites, and connected to the phone company network.

CSU - Channel Service Unit. A digital interface device that connects end user equipment to the local digital telephone loop.

datagram - a logical grouping of information sent as a network-layer unit over a transmission medium without prior establishment of a virtual circuit.

de facto standard - A standard by usage rather than official decree; a default standard

de jure standard - A standard by official decree

demarc - demarcation point between carrier equipment and private telephone equipment (CPE).

designated router - generates a link state advertisement for a multi-access network.

device - an entity that can access a network (used interchangeably with node).

dial-up line - communications circuit that is established by a switched-circuit connection using the telephone network.

directory services - services that help network devices locate service providers.

DS1 - Digital transmission system 1 referring to 1.44 Mbps

DS3 - Digital transmission system 3 referring to the 44 Mbps

DSU - Data Service Unit. A device used in digital transmission for connecting a CSU to a DTE.

DVI - Digital Video Interactive - offers Real Time Video (RTV) and Production Level Video (PLV) compression at a ratio of up to 160-to-1. RTV compresses video in real time, while PLV compresses stored video.

EBCDIC - Extended Binary Coded Decimal Interchange Code. An 8-bit character code developed by IBM for data representation in their large mainframe computer systems.

enterprise network - a usually large, diverse network connecting most major points in a company, usually private and contained within a single organization.
Ethernet - a baseband LAN specification invented by Xerox operating at 10 megabits per second using CSMA/CD to run over coaxial cable.

Ether Talk - AppleTalk protocols running on Ethernet.

EIA - Electronic Industries Association that specifies electrical transmission standards (RS-232C).

electronic mail - widely used network application where mail messages are transmitted electronically between end users over various types of network using various network protocols.

FDDI - Fiber Digital Distributed Interface - Fiber optic backbone networks with clock rates of 100 Mbps.

file transfer - one of the most popular network applications whereby files can be moved from one network device to another.

Frame Relay - A protocol used across the interface between user devices (for example, hosts and routers) and network equipment (for example, switching nodes).

FTAM - File Transfer, Access, and Management. An OSI application developed for network file exchange and management.

FTP - File transfer Protocol. An IP application protocol for transferring files between network nodes.

full duplex - a capability for simultaneous transmission of data in both directions.

gateway - older term referring to a routing device.

HSSI - High Speed Serial Interface - physical interface and defacto industry standard for high-speed serial transmission between data terminal equipment and data communications equipment, at speeds up to 52 megabits per second. It defines the physical layer for transmission but doesn't define the transmission protocol.

handshake - sequence of messages exchanged between two or more network devices to ensure transmission synchronization.

heterogeneous network - a network consisting of dissimilar devices that run dissimilar protocols and in many cases support dissimilar functions or applications.

hub - term used to describe a device that serves as the center of a star-topology network.

hybrid network - an internetwork made up of more than one type of network technology, including LAN's and WAN's.

IEFT - encapsulation standard allowing TCP/IP and ATM nets to exchange data.

infrared - electromagnetic waves whose frequency range is above that of microwave, but below the visible spectrum.

Integrated Intermediate System-to-Intermediate System-provides routing for both TCP/IP and Open Systems Interconnection standards.

Internet address - IP 32-bit address assigned by hosts using TCP/IP.
interoperability - connecting networks together involving products, procedures and technologies.

internetworking - connecting individual networks together involving products, procedures and technologies
interoperability - the ability of computing equipment manufactured by different vendors to communicate successfully over a network.

IP - Internet Protocol layer 3 containing addressing information and some control information that allows packets to be routed.

ISDN - Integrated Services Digital Network

JPEG- CCITT and ISO's Joint Photographic Experts Group for formatting still-image compression and full-motion video.

LAN - Local Area Network covering a relatively small geographic area (campus of buildings).

LEC - public network Local Exchange Carriers

line of sight - characteristic of certain transmission systems such as LASER, microwave, and infrared systems where no obstructions on a direct path between transmitter/receiver may exist.

MAN - Metropolitan Area Network spanning a metropolitan area.

MESH - network nodes interconnected to all other nodes for complete redundancy of networking (as in mesh pattern)

MIB - Management information base. A collection of objects that is structured according to the rules specified in the SNMP standards
(1) standard MIB - contains 200 objects and is detailed in the Internet's Request for Comments 1213

(2) experimental and draft MIB's-under evaluation only or under consideration for eventual adoption as standards

(3) private MIB's-objects only the managed device agents of a particular vendor supports

microsegmenting - use of intelligent or switching hubs to break networks into small segments.

microwave - electromagnetic waves in the range 1 to 30 gigahertz for high-bandwidth networks.

MNP5 - 2 to 1 modem data compression

MNP4 through MNP10 - error correction levels for modems

modem - modulator-demodulator device that converts digital signals into a form suitable for transmission over analog communication facilities and vice versa.

MPEG - ISO's Motion Picture Experts Group standard to format video clips at compression ratios from 50-to-1 up to 200-to-1.

Multiprotocol routers-routes data at gigabit-per-second speeds, provide advanced network management and support high levels of redundancy and fault tolerance.

NEARNet - The New England Academic and Research Network

NetWare Link Services Protocol - Novell developed protocol

NIC - Network Information Center containing Internet information.

NFS - network file system, a distributed file system protocol suite.

NREN - National Research and Education Network

NSFnet- National Science Foundation network

OBJECT-A single element of management information. To be queried and responded to, an object needs to be defined in the same way in both the agent and the SNMP management station. Each object is defined by an object ID, which is a unique number sequence for the particular object; an object type, which includes definitions of the value of the object as an integer, a counter or text string; and an access, which defines the object as read-only or read-write, for example.

open architecture - an architecture to which third-party developers can legally develop products and for which public domain specifications exist.

Open Shortest Path First protocol - TCP/IP improvement over Routing Information Protocol.

OSI - International Organization for Standardization.

OSI Reference Model - a network architectural mode developed by ISO and CCITT consisting of seven layers used for teaching and learning network functionality.

OSPF - Open Shortest Path First link-state protocol, routers pass along information about the entire network topology, and each router computes the shortest path between specific nodes.

packet switching - nodes share bandwidth with each other by intermittently sending logical information units (packets).

peer-to-peer computing - as contrasted with client-server computing, peer-to-peer computing calls for each network device to run both client and server portions of an application.

Px64 - CCITT standard suite for videoconferencing that includes the H.261 standard. Allows for connections between videoconferencing codecs made by different vendors using single or multiple 64 bit/sec circuits

PPP - Point to Point Protocol for providing router-to-router and host-to-network connections over synchronous and asynchronous circuits.

print server - a networked computer system that fields, manages, and executes (or sends for execution) print requests from other network devices.

protocol - a formal description of a set of rules and conventions that govern how devices on a network exchange information.

protocol translator - a network device or software that converts one protocol into another.

Quick Time- Apple standard enabling MacIntosh users to create, store, transmit and play back compressed video at rates of between 15 and 30 frames per second

RBOC - Regional Bell Operating Companies.

RIP - Routing Information Protocol is a distance-vector protocol, routers pass information to other routers about how difficult it is for data from neighboring nodes to reach a LAN.

routers - intelligent devices which can automatically route data among local and remote LAN's.
routing tables - a table stored in a router or some other internetworking device that keeps track of routes and metrics associated with those routes to particular network destinations.

ROUTER INTEROPERABILITY OBSTACLES
- Varied Interpretations of routing protocol by vendors
- Deployment of options such as data compression in protocol
- Distinct user interfaces in routers
- Different command syntax's for router operation
- Incomplete standards for wide-area communications

SET-An SNMP message format. A set permits an operator at an SNMP management station to change the value of any object retained within an SNMP agent that is defined as read-write. A set message lets the manager actively control, rather than passively monitor, remote devices.

satellite communications - use of geostationary orbiting satellites to relay data between multiple earth-based stations.

security management - one of five categories of network management defined by ISO for management of OSI networks.

server - a node or software program that provides services to a client.

smart hubs - 10Base T standard for Ethernet LANs offering basic management information

SLIP - serial line IP

SMDS - Switched Multimegabit Data Services, a connectionless, high-speed, public packet-switched data service defined by Bellcore and being implemented by the RBOC's and other LEC's. Operates at speeds from 1.544 bps to more than 155 Mbps.

SMTP - simple mail transfer protocol for providing electronic mail.

SNMP - Simple Network Management Protocol used in TCP/IP based systems

SQL - structured query language for data base calls.

Switched 56kb - Digital switched circuits

TDD - Telecommunications Device for the Deaf

Telnet/OLTP - "turbo-charged" telnet batching multiple characters into a single packet.

T1-Bell system - terminology referring to a digital carrier facility used for transmission of data through the telephone hierarchy at a rate of 1/544 Mbps (Megabytes per second)

TRAP: An SNMP message format referred to as an event or alarm. A trap is issued unilaterally by a managed device when it recognizes that a specific predefined condition or threshold has been met. The SNMP standards define six generic trap conditions.

UNIX - Operating System
USENET - One of the oldest and largest cooperative network with many computers and users connected, primarily f

UUCP - UNIX to UNIX Copy Protocol
Update-Based-Protocol - Apple computer developed

USENET - cooperative network distributing conference services and news

V.fast - a CCITT standard for modems operating at 28.8 kb per second over ordinary phone lines. "V.fast's promised speeds are also enticing organizations with data-intensive applications such as electronic publishing, medical imaging, low-bit-rate video and remote LAN access to consider modems and dial-up lines as an alternative to digital technologies like ISDN and switched services."

v.32terbo - a modem specification with speeds up to 19.2 Kbps.

v.32bis - modem standard for speeds up to 14.4 Kbps

v.32 - modem specification with speed of 9.6 Kbps.

v.42 - 4 to 1 modem data compression increasing data transfer speed

Video for Windows - Microsoft standard enabling Windows users to create, store transmit and play back compressed video at rates between 15 and 30 frames per second. Supports the Audio Visual Interleave compression standard.

WaveLAN - wireless LAN using spread-spectrum radio in the 902-to-928 megahertz frequency band.

WAN - Wide Area Network. A network spanning a wide geographic area.

wiring closet - Specially designed room used for wiring data and voice networks. Wiring closets serve as a central junction point for wiring and wiring equipment that is used for interconnecting devices.

X.25 - a CCITT standard that defines the packet format for data transfers in a public data network.

X.400 - A CCITT recommendation specifying a standard for electronic mail transfer

X.500 - A CCITT recommendation specifying a standard for distributed maintenance of files and directories

XNS - Xerox Network Systems. A protocol suite originally designed by Xerox PARC. Many PC networking companies, such as Ungermann-Bass, Novell, Banyan, and 3Com, used or currently use a variation of XNS as their primary transport protocol stack.

X Windows - Distributed, network-transparent, device-independent, multitasking windowing and graphics system originally developed by MIT for communication between X terminals and UNIX workstations.

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APPENDICES

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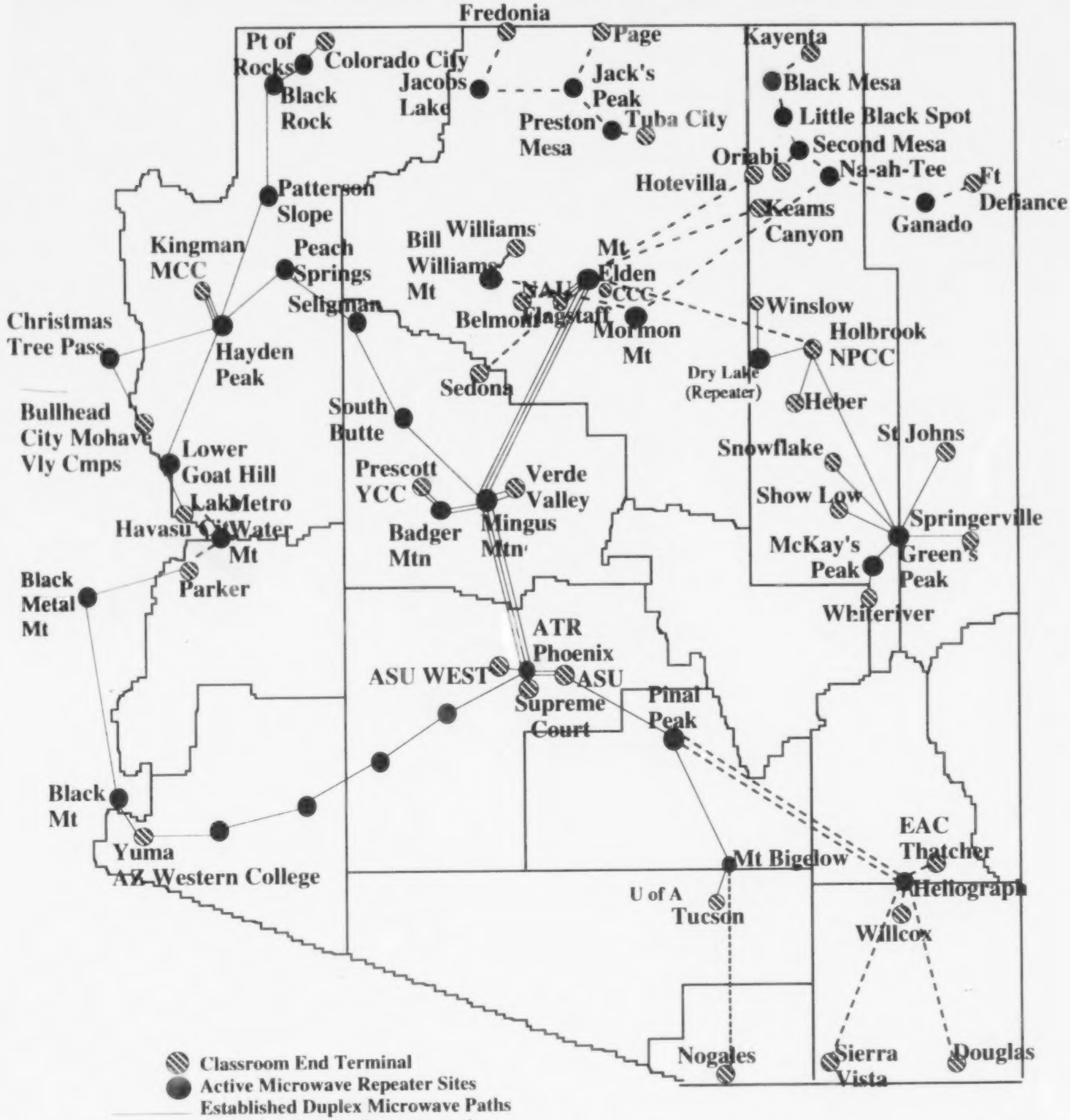
APPENDIX A

EDUCATION MICROWAVE
In Place & Future Connections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Hotevilla
Na-ah-Tee
Ft Defiance
Keams Canyon
Ganado
Patterson Slope
Kingman MCC
Peach Springs
Williams
Bill Williams Mt
Mt Elden
NAU
CCC
Flagstaff
Belmont
Mormon Mt
Seligman
Winslow
Holbrook NPCC
Christmas Tree Pass
Hayden Peak
Sedona
Dry Lake (Repeater)
Heber
Bullhead City Mohave Vly Cmps
South Butte
Snowflake
St Johns
Lower Goat Hill
Prescott YCC
Verde Valley
Show Low
Lake Havasu City
Metro Water Mt
Badger Mtn
Mingus Mtn
Springerville
McKay's Peak
Green's Peak
Black Metal Mt
Parker
Whiteriver
ATR Phoenix
ASU WEST
ASU
Supreme Court
Pinal Peak
Black Mt
Yuma AZ Western College
EAC Thatcher
Mt Bigelow
Heliograph
U of A Tucson
Willcox
Nogales
Sierra Vista
Douglas

▨ Classroom End Terminal

● Active Microwave Repeater Sites

Established Duplex Microwave Paths

Future Microwave Interconnections

AANG - AZ Army National Guard
ASU - AZ State University
ATR - American Televsion Relay (Hub)
AWC - AZ Western College
CCC - Coconino County College
EAC - Eastern AZ College

MCC - Mohave Community College
NAU - Northern Arizona University
NPC - Northland Pioneer College
U/A - University of Arizona
YCC - Yavapai Community College

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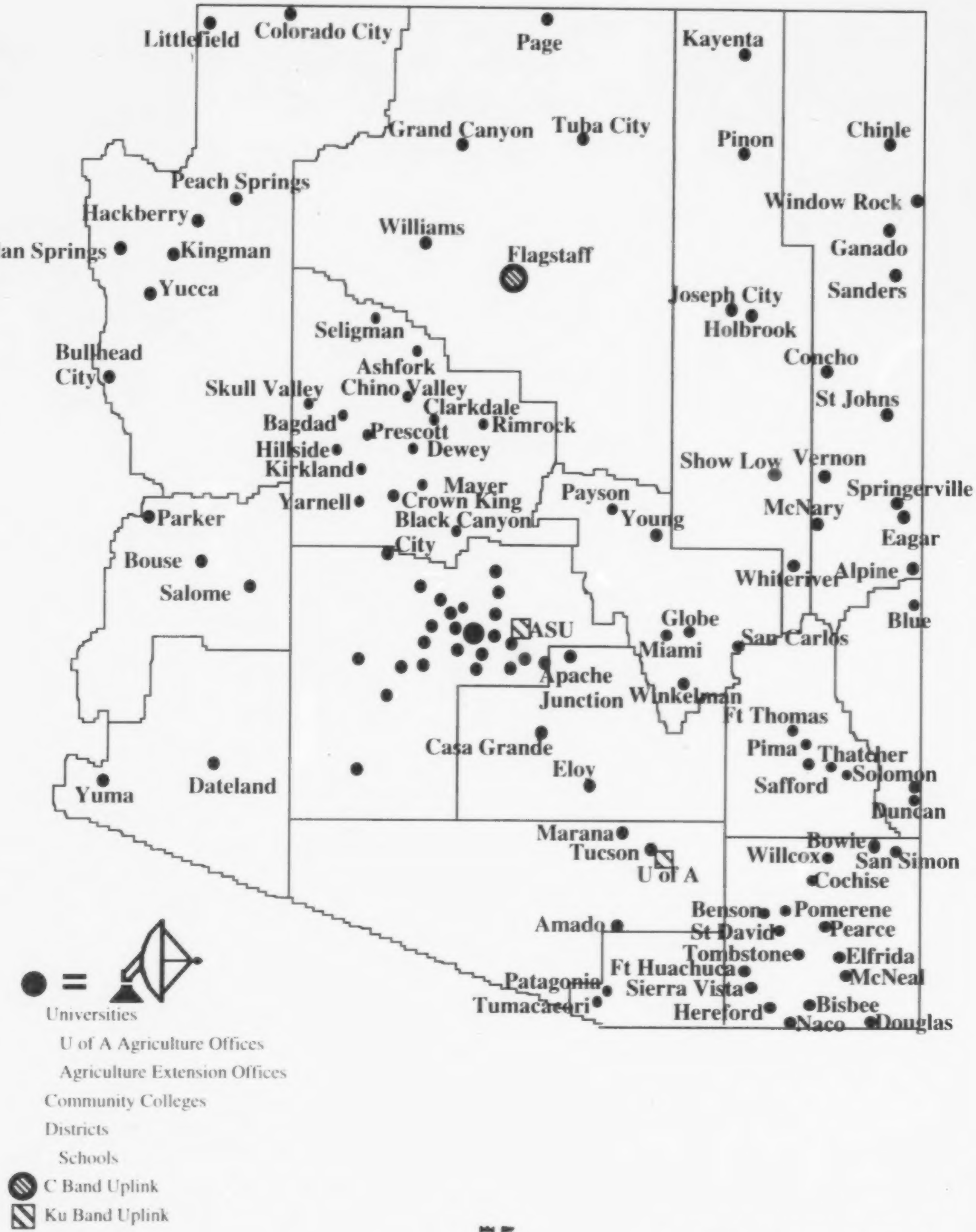
SATELLITE NETWORK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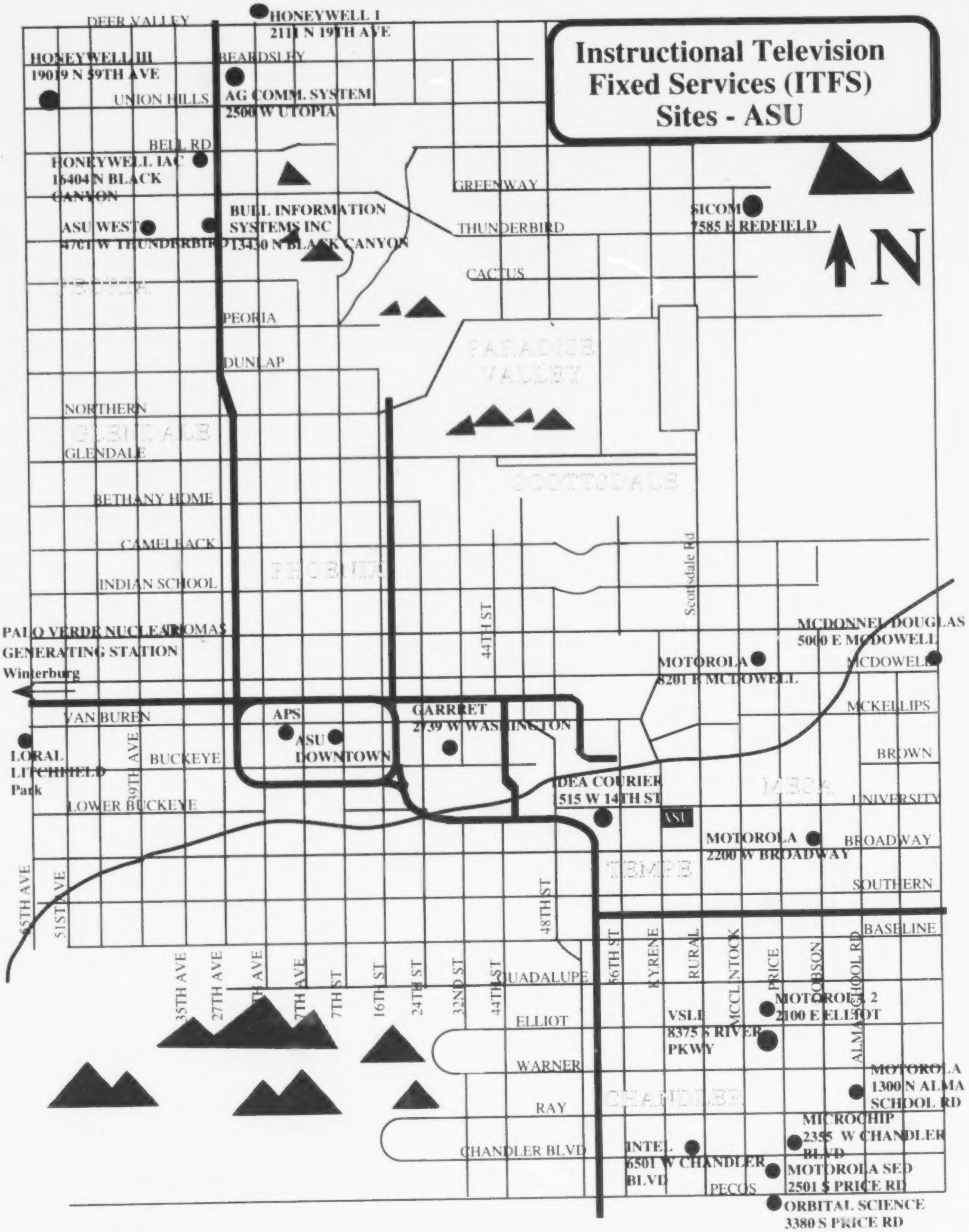
Instructional Television Fixed Services (ITFS) Sites - ASU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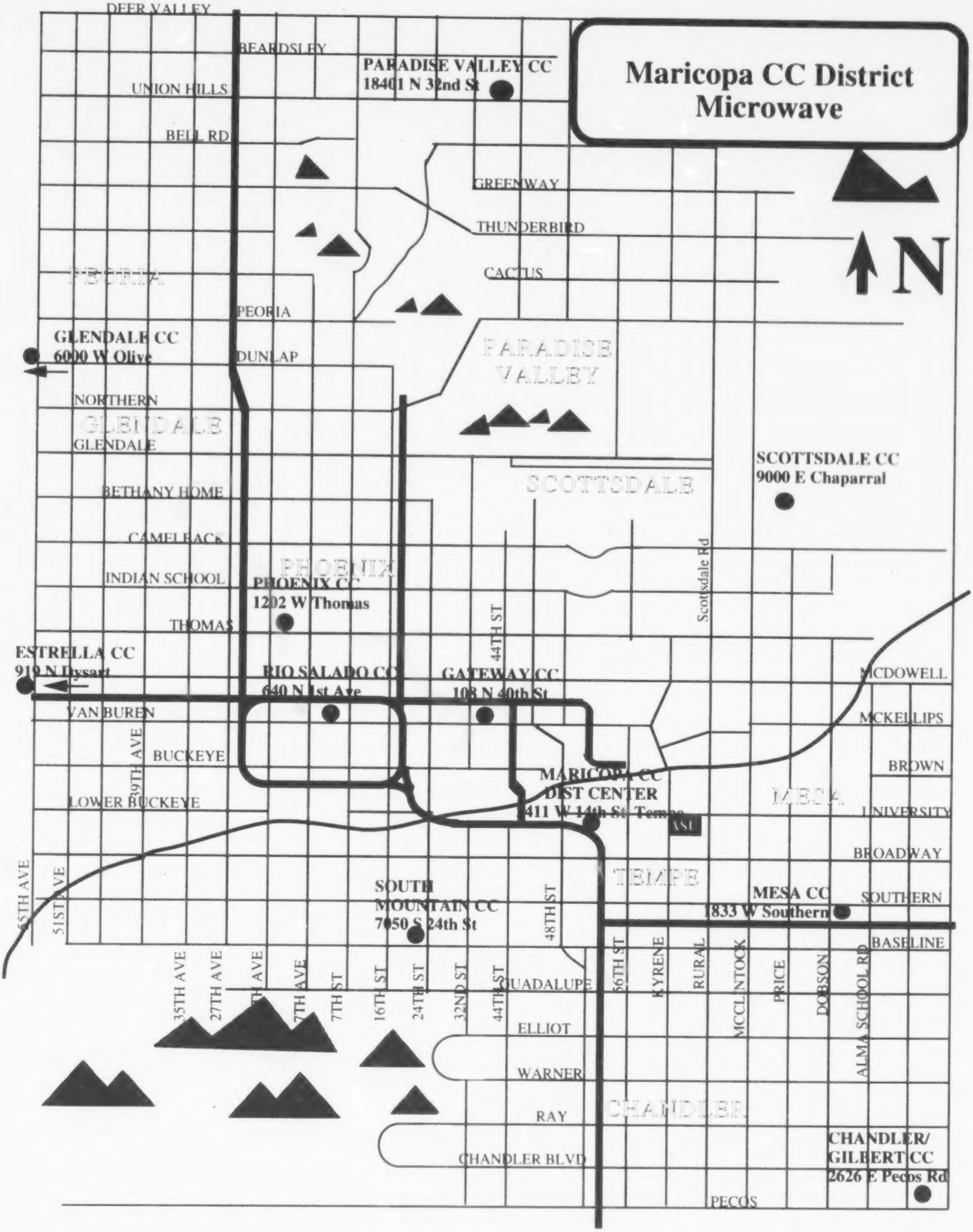
Maricopa CC District Microwave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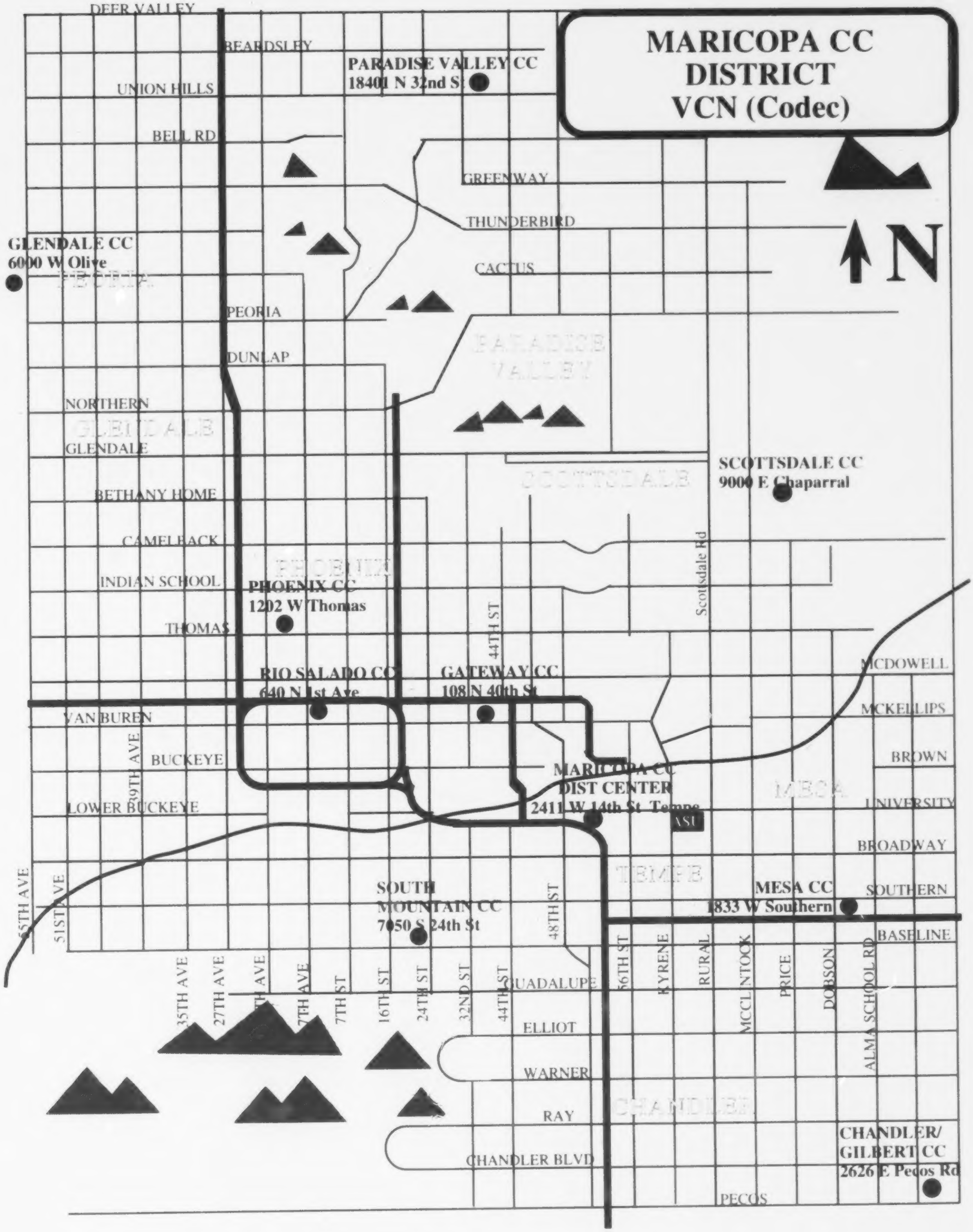
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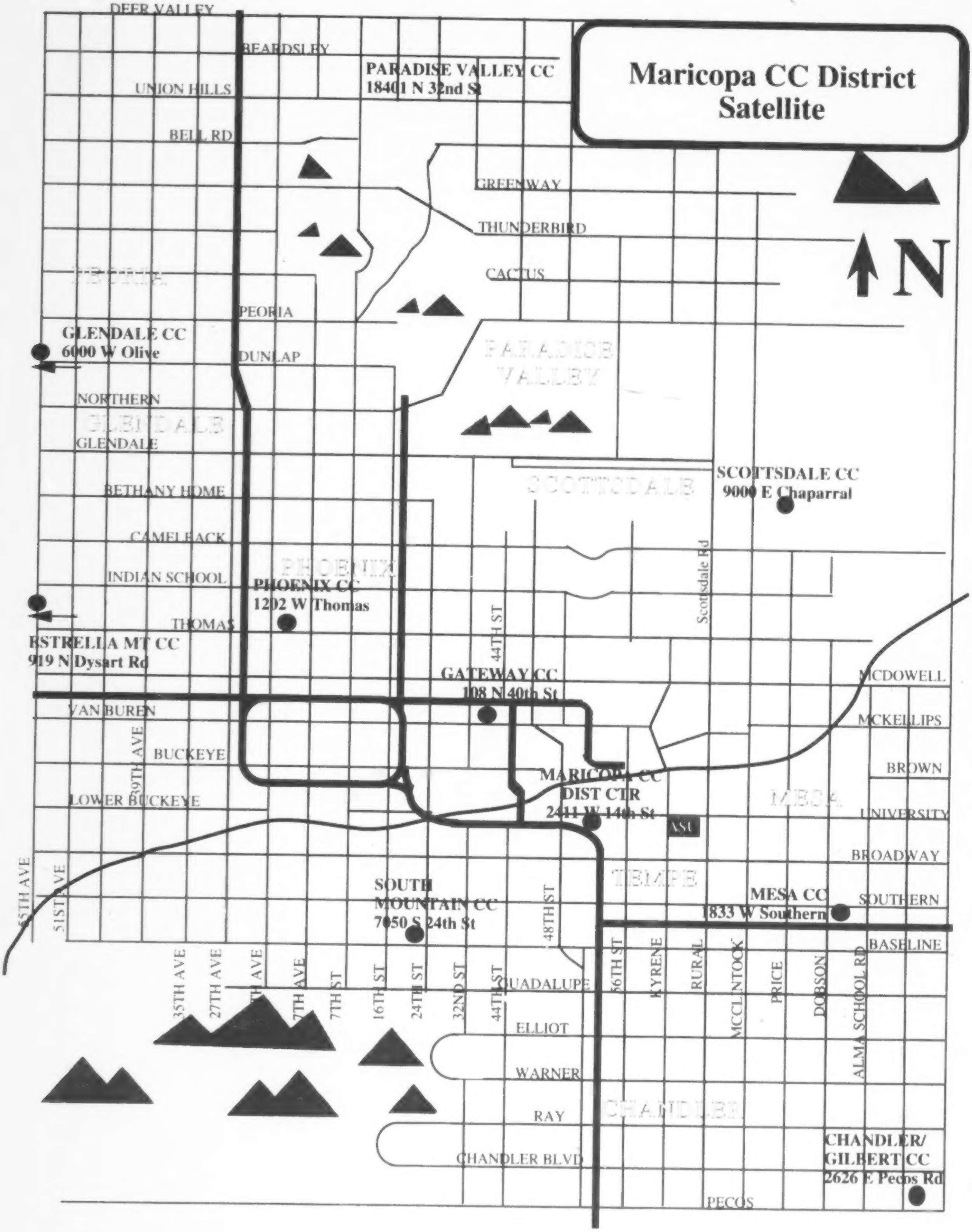
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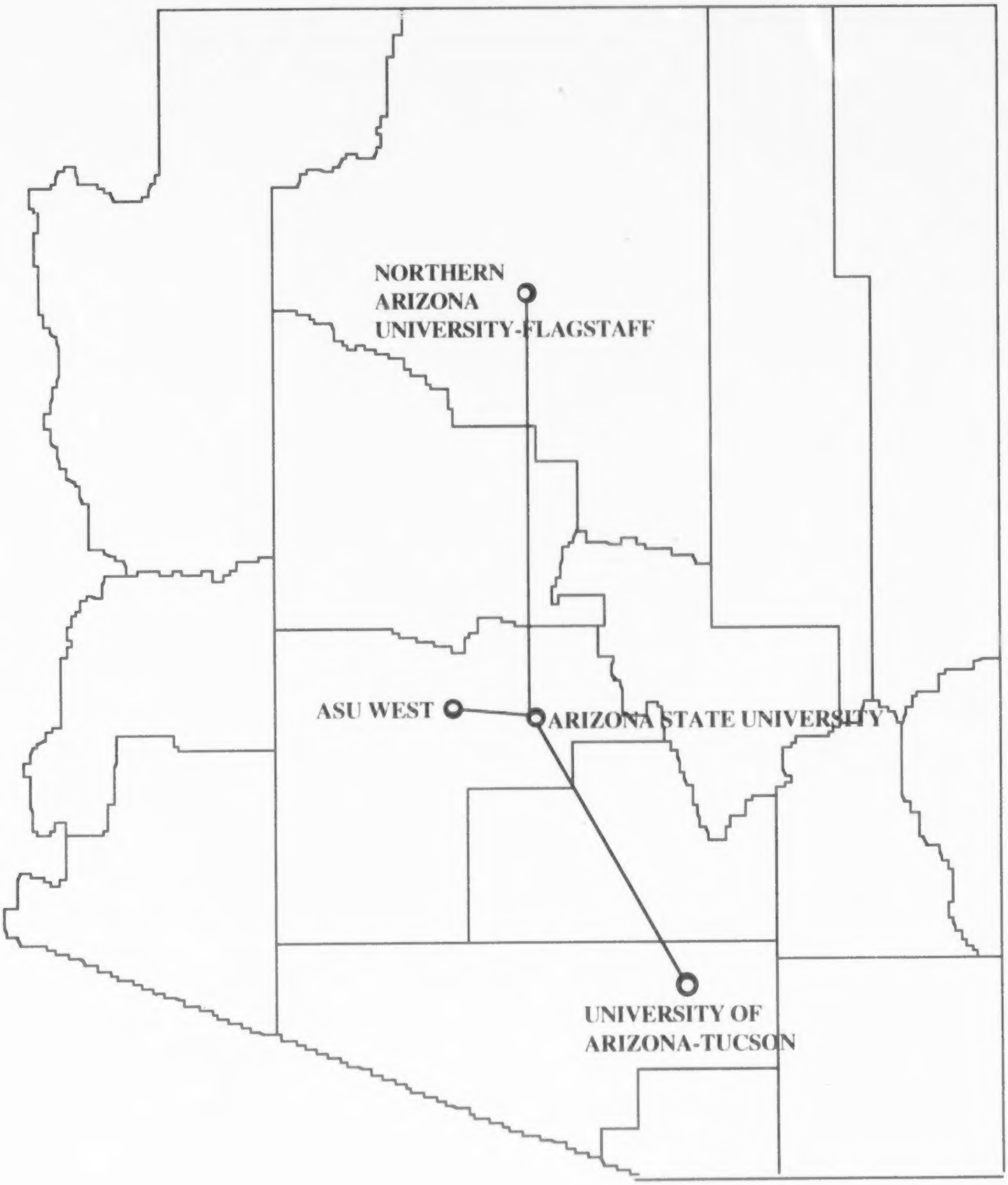
PRESIDENT'S COUNCIL CODEC CONNECTIONS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UNIVERSITY OF ARIZONA-TUCSON

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APPENDIX B

LOW COST, ROBUST K-12 CONNECTIONS TO THE INTERNET

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Technical Session
for the ISTE Conference
Denver, CO
October 2-5, 1992

Abstract

We discuss establishing Internet connections to the K-12 community. We begin with an overview of the Internet, with particular emphasis upon NSFNet. We then present the hierarchy of networking, from the NSFNet backbone, through regional networks, to the site and deployment of Local Area Networks. Next we discuss networking growth curves, based upon our experience and projecting to an improved model. The benefits of networking are then illustrated through exposition of several projects at Rocky Mountain High School. Finally, we explore strategies to connect the K-12 community to the Internet, and recommend technological solutions.

1. Overview of Networking and the Internet

We begin by describing networking. Most of us are familiar with the connotation of the word in the sense of interpersonal *networking*, i.e. establishing and nurturing strategic contacts with individuals, keeping information flowing, etc. *Computer networking* is much the same, except with computers. Many individual computers are interconnected with a digital data communications network. This provides the capability to pass data across digital data circuits (special types of telephone lines). Here, digital means that data are passed as bits and bytes (a byte is 8 bits), rather than as sound (such as is passed across a modem from a home computer, for example). Digital data can be passed much more rapidly than sound data.

The types of data passed can include computer codes and output, allowing one to compute on remote computer systems such as supercomputers (indeed, this was the principal reason that the NSF embarked upon networking in the early 1980's). There are also repositories of free software (called "freeware") for all types of computers. Data bases too can be passed, including: card catalogs of libraries, on-line documents, including technical papers, national and international news articles, announcements for conferences and workshops, applications for conferences, etc. Color and black and white pictures in the form of electronic images can be passed, including NASA images from space probe missions, weather maps, etc.

An exciting application available via the network is Network News, also called NetNews.- NetNews is a public data base containing hundreds of Newsgroups organized by topic. There are many topics, covering diverse interests. What is notable about NetNews is that it is formulated and read by individuals on the network. Thus, if one is travelling and desires to gather information on good hotels or restaurants in the city of your destination, one can access NetNews articles on these topics. One can also access topics covering diverse products. When buying a bicycle, it is useful to view the opinions of others as to the their experiences with particular brands. Some say that this is the last defense we, the general public, have against rampant commercialism, as individuals who "post" articles to NetNews (generally) have no vested interest in a particular product.

Furthermore, an individual using one computer on the network can "talk" to an individual on another computer on the network using a split screen - everything typed by user #1 appears in the top screen, and the typing of user #2 appears in the lower box - on both computers as soon as it is typed. This dialog happens almost immediately. This is extensible to more than two users by using the "chat" facility. Electronic mail can be sent to one or many users, simply with the press of a button - requiring no stamp or envelope, and all of this action happens in fractions of a second.

We now turn our attention to the organizational structure of the Internet. The Internet is a hierarchy of networks. The highest level network that spans the country is the NSFNet, as shown in Figure 1. The NSFNet can be considered to be a very high speed "backbone" network, into which other networks of lower level connect.

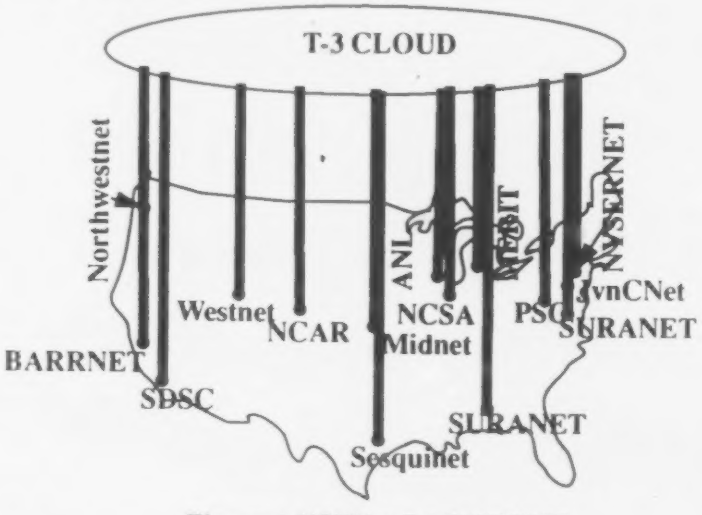


Figure 1 NSFNet BACKBONE

The next hierarchical level of network is the regional network. Regional networks span large areas of the country, and provide "plugs" into the NSFNet backbone. The "plugs" into the NSFNet from the 15 regional networks are shown in Figure 1. A closer look at our regional network, Westnet, is provided as Figure 2.

Westnet, from its two "plugs" into the NSFNet backbone, deploys the network to its Primary Nodes shown in Figure 2. From there, the network is distributed to all other nodes within the region. Normally, all nodes within the region "plug into" Westnet's primary nodes. Note that Westnet has two gateways to the backbone - one at the National Center for Atmospheric Research (NCAR) in Boulder, CO and the other at the University of Utah in Salt Lake City, Utah. The NSFNet is like a backbone, which conveys the central nervous system to the body, from there the

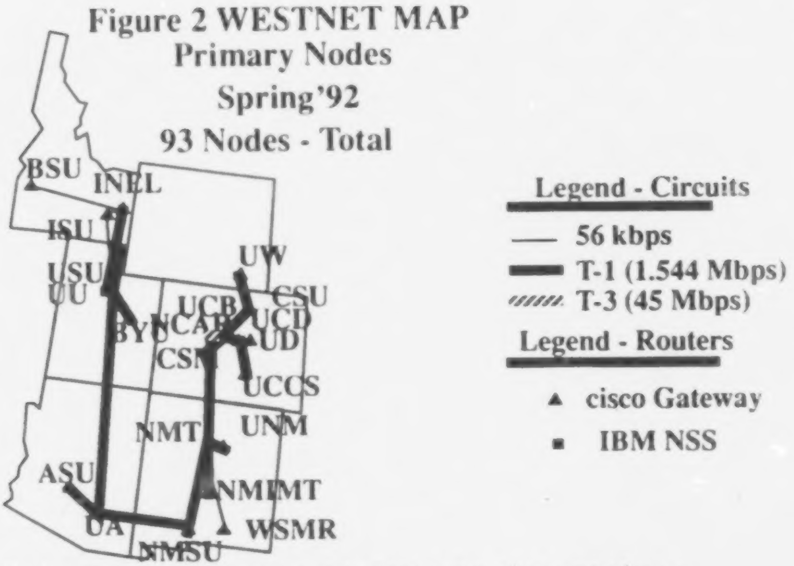


Figure 2 WESTNET MAP
Primary Nodes
Spring'92
93 Nodes - Total

regional network is like a limb, conveying the nervous system out to the appendages.

Below Westnet are a number of state networks, including Colorado SuperNet, New Mexico Technet, UtahLibNet, and WyoTechNet. Arizona and Idaho have associations which manage the network in their states. Individual sites are members of these state networks, which are in turn members of Westnet which is a member of the NSFNet. In Westnet, then, an individual connection is made through the state network. However, we note that connection models vary from region to region.

1.1 Connection Speeds

The networking community, like any other community has its own technical jargon. It is necessary to be versed in it to facilitate entering into a connection agreement. In particular, connections of various speeds and types can be made. In Table 1, we list connection speeds, and try to put them into terms that all can understand. We begin with digital connections. Digital connections are specified in terms of *bps* (bits per second), with *kbps* being thousands of bits per second, and *Mbps* millions of bits per second. Digital connections transmit digital data as 0's and 1's; thus all text and pictures are translated into 0's and 1's, and transmitted and reassembled into their original form on the other end. The highest speed digital connection currently available is termed a T-3 connection, which is the speed of the NSFNet backbone, and continue with T-1 speed, the next highest speed typical of the primary nodes within Westnet. The lowest speed digital connection is 56 kbps, which was the speed at which all nodes were connected in 1986.

In addition to digital connections are analog connections, where instead of data being transmitted as 0's and 1's, data are transmitted as sound waves (similar to speaking across a telephone line). Analog connections are specified in *baud* (binary audial digits). One *baud* is equivalent to one *bps*, except the former is transmitted over an analog circuit, and the latter is transmitted over a digital circuit. Again for analog circuits, data are converted and reassembled in a fashion that is transparent to the user, as long as one orders all equipment compatible to do so.

Table 1: Transmission Types and Speeds

Name	Raw Circuit Speed	Speed	Transmission Times		
		Words/Min.	Color Picture	The Bible	Encyclopedia Brittanica
T-3	45 Mbps	67,000,000	0.5 Sec.	1.2 Sec.	60 Sec.
T-1	1.544 Mbps	2,000,000	15 Sec.	36 Sec.	30 Min.
56 kbps	56 kbps	75,000	7 Min.	16 Min.	13 Hrs.
14.4 kbaud	14.4 kbaud	19,000	1/2 Hr.	1 Hr.	2 days

2. Specific Connections to K-12

We address establishing connectivity to the Internet for K-12 schools. In particular, our focus will be to connect school districts, i.e. we recommend providing only one connection per school district. This provides the greatest economy, while maintaining scalability. The school district is the logical place for the "hub" of the network, which can be used to receive the NetNews feed, and to receive electronic mail for the district. This relieves these burdens from individual schools, which are then free to get on with establishing their local area networks, and education in the classroom.

The rationale here is that, once a single school in the school district becomes connected, the remainder of the school district will become connected after they see the value in the single connection (an element of "keeping up with the Joneses" exists here). Indeed, we have observed just this situation with Rocky Mountain High School (RMHS) in Fort Collins, which became connected to the Internet in 1990 using donated equipment. Colorado SuperNet donated a Cisco MGS Gateway, and IBM donated two RS 6000's and one X-terminal. This project was so successful that the entire school district (the PR-1 School District) established connectivity through RMHS during the Fall of 1991, at a cost of almost $200,000! This large leverage ratio has existed for networking in general across the nation. During government fiscal year 1989, the higher education schools in the Westnet region spent $31 for every $1 of NSF investment in Westnet! It is absolutely critical to establish initial connectivity, as this catalyzes the rapid spread of technology.

2.1 Networking Growth Curves

The Rocky Mountain High School pilot program has followed a growth curve that initially was nearly vertical (see Figure 3). Having been deeply involved in the RMHS pilot program, we have gained much perspective. The RMHS experience provides valuable guidance as we assist other schools in connecting to the Internet. One of the main points that the RMHS project highlights is the issue of UNIX in the high school. The task of learning Internet protocols (*telnet*, *ftp*, etc.) and learning to manage a UNIX system proved, at times, almost too much for those involved in the project. The dedicated teachers at the high school spent many late evenings and long weekends of their own time coming up to speed in UNIX. By being located only a mile from the high school, CSU was able to provide "house call" service to assist with networking and UNIX difficulties. Presently, those involved in the RMHS project feel a glow of success, but they recall frequent, painful times that led to that success. Partially because of the experiences of the RMHS project and partially because of recent connectivity advances that allow fairly high quality network access without an on-site UNIX machine, we propose a less challenging model for the next wave of K-12 schools that we assist in connecting to the Internet.

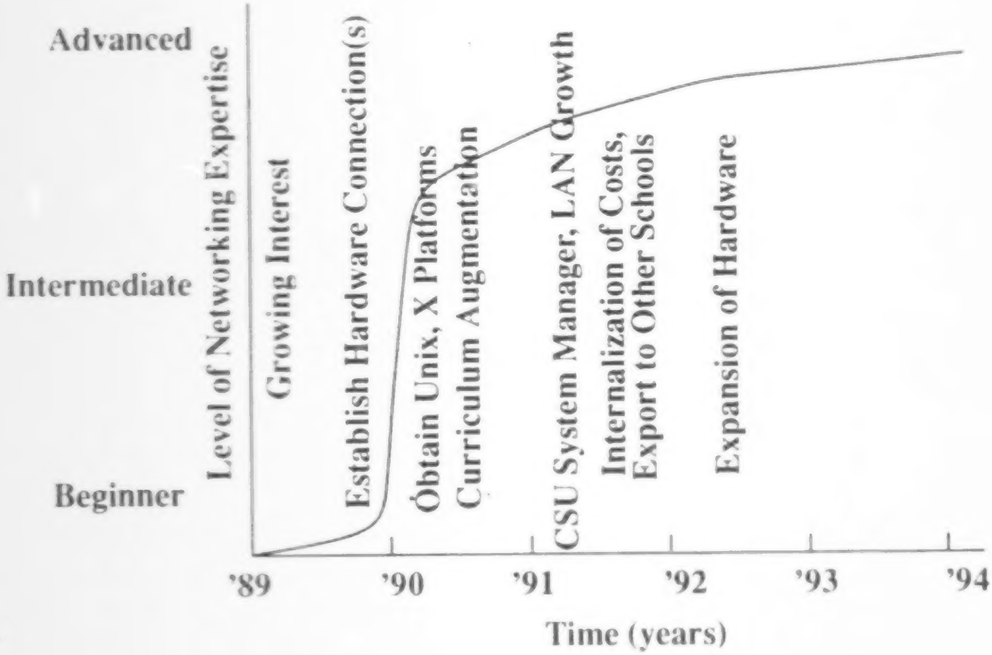


Figure 3 Rocky Mountain High School Networking Growth vs. Time

The strategy is to provide to the individual school the "plug" for the local Ethernet Local Area Network (LAN). We surmise that the growth of networking under such a model would appear as shown in Figure 4, over a five year period. Such a growth curve mandates a multi-year effort.

Since the RMHS pilot program was largely a "bootstrap" operation, few in-service training sessions in the use of the Internet were conducted. This was due partly to a lack of resources, and partly to a lack of a mature knowledge base for directing the RMHS program. Using the considerable knowledge and experience base gained from the RMHS effort, we now are in a position to infuse networking and associated educational aspects into schools as they join in our effort.

3. Typical Uses of the Internet in the Classroom

"Education is that which remains when one has forgotten everything one ever learned in school." - A. Einstein, *Out of My Later Years, On Education,*

"In science, it is not so much what one knows, but how and why one knows it." - B. Russell,

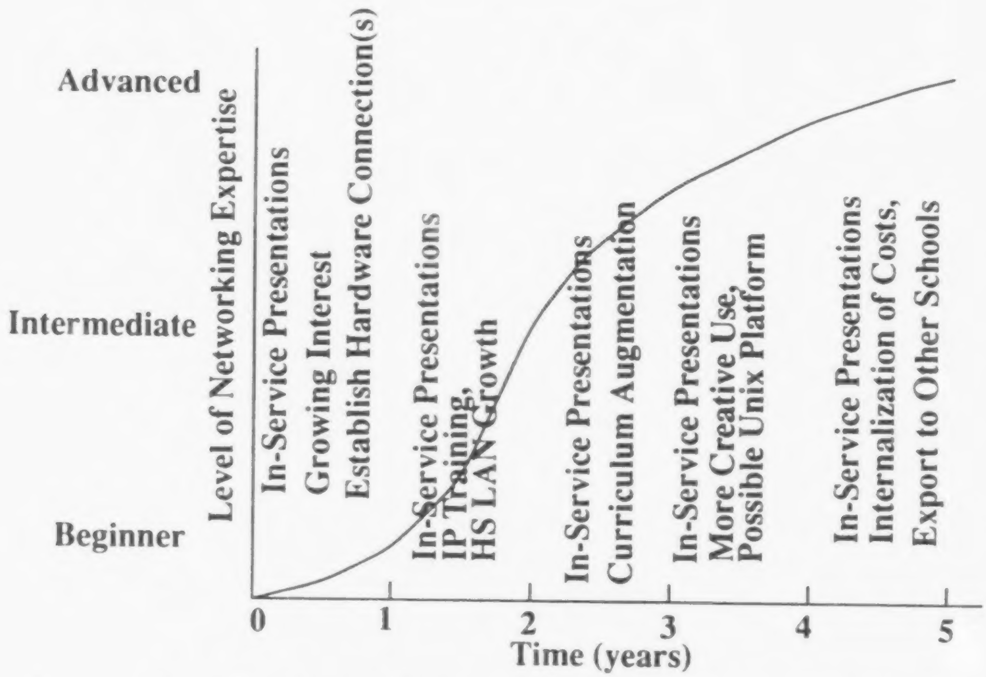


Figure 4 Typical High School Networking Growth vs. Time

History of Western Philosophy.

Education may be interpreted as teaching one to think, while training may be interpreted as teaching one to do. It is the theme of this effort that the proper blend of these two approaches is necessary to be maximally effective. Indeed, we perceive that about 85% education and 15% training is an appropriate division of approaches.

"Idols of the Schools is thinking that some blind rule can take the place of judgement." - Francis Bacon.

The traditional approach to education is to treat students as recipients of information. Our approach is to treat students as generators of information by requiring them to take the intellectual steps required to gain knowledge. This necessarily heavily involves hands-on experience. We view computational capability, including networking, as most appropriate to involve students in the process. Computers are largely responsible for the information explosion. Used properly, computers should serve the educational community in managing this explosion. To this end, we propose the extension of computing infrastructure to the K-12 community. Initially, this will involve primarily high schools. Our goal is the construction of a "seamless web" of computing infrastructure from K-Ph.D. These activities are epitomized in the following quote:

"The restructuring of the American school is becoming a reality. National, state and local political leaders are sounding the cry for changes which will improve our educational system and global economic clout." Owen Smith, Proceedings of the RAMJET Committee, Colorado State University, 1991.

Here, we briefly provide some of the uses which have been found for networking in the classroom - specifically in high schools. Among the most common uses is electronic mail, which is used to communicate with others who have access to remote computers. For example, Dave Swartz at

Rocky Mountain High School teaches a class in Environmental Studies. His students have access only to our western ecosystem. However, to overcome this limitation, Dave's students correspond via electronic mail with students in Australia and Newfoundland - both with radically different ecologies than Colorado. Students at all sites collect data particular to their area of the country, and all share the data for analysis. Thus, it is possible to broaden our parochial viewpoint, which is geographically limited.

Foreign language teachers use the Internet (the "network of networks" spanning the globe) to communicate with foreign students. For example, a German teacher in the USA might have his or her students writing electronic mail letters in German to students in Germany, who respond in English. Each set of students critiques the others contributions, providing an interactive educational experience in both their native language (explaining elements of grammar to foreigners) and the language under study. Also, some unique cultural exchanges can be fostered in this fashion.

Some journalism classes at Rocky Mountain High School in Fort Collins have been exchanging newspaper articles in an Academy One project via the Cleveland FREENet. In this activity, articles are posted, and thereby made available to all participants. The articles tend to have a distinctly regional flavor, promoting cross-cultural awareness and an expansion of our societal mores. Also, this is an excellent way to obtain many articles for the school newspaper for every one that is written locally.

An emerging area is that of visualization across the Internet. Currently, the focus is on X-windows applications, requiring an X-windows interface. There are many free X-windows software packages and X-images available via the Internet. Particularly, there are many beautiful images captured by NASA from the Hubble telescope, the Magellan and Viking missions, etc. When studying astronomy in the classroom, instructors have found such images of great value to involve students in large-scale science of national scope. Finally, there are weather maps of varying scale available - which are only 20 minutes old (students are beforehand able to tell their parents what they will see on the weather forecast on the nightly newscast). The scales of the weather maps range from the North American continent to local Colorado maps.

These are just examples of the many uses of networking. In fact, by participating in networking, users will be involved in establishing "leading-edge" uses of networking. When widespread networking was begun over five years ago, no one had the remotest notion how widely and diversely networking would be used. The network has been a success beyond our wildest dreams; it is truly changing the way we conduct our lives. Some have said that the network was built on the "field of dreams" philosophy - *Build it and they will come*. We encourage participation in this exciting and stimulating endeavor.

Networking enhances learning in a variety of ways. First, it pro-actively involves students in their work. Secondly, it encourages students to compose well written articles (with good grammar, paragraph structure, spelling and punctuation) for transmission across the Internet to their peers. Thirdly, there is a tremendous volume of material available via the Internet, and some emerging technologies for topically searching library data bases, both quickly and easily. All of this is accomplished in seconds, with messages transmitted anywhere in the world, requiring not even a postage stamp!

4. Technology

Our intent is to recommend technology that will provide: (1) a robust connection to the Internet, (2) the capability to perform visualizations on local workstations, and (3) an environment that will facilitate management by the regional Network Operations Center (NOC). In particular, we eschew asynchronous dial-in as it either lets only one user at a time onto the Internet, or an expensive terminal server is required. Additionally the network then exists only at the remote dial-in site, and is not conveyed to the school - this presents the user with one additional layer to deal with, and we desire to avoid this.

We propose full, digital circuit 56 kbps Internet connections to be provided to "hub" sites, such as school districts (these could even be community colleges, etc.). At these "hubs," there would be a Unix platform for receiving electronic mail and the NetNews feed. Individual schools could connect via dial-in to the hub at 14.4 kbaud through an inexpensive telephone circuit, or connect via a 56 kbps digital circuit. Then, Junior High /Middle Schools could connect to the High Schools via dial-in. Thus, the school district would serve as the "hub" of a "star" network configuration, as the direct connections to the schools would be "tail" circuits (no connections beyond them). Such a topology is shown in Figure 5. The details of this are shown in Figure 6.

At the high school, we propose that an Ethernet LAN be established as the best path for growth and scaling up the Internet connection. Also, to engage effectively in visualization, the high school would need to be running an X-Windows server.

We label the above three connection models as numbers 1 through 3. Models 1 and 2 are for establishing connections of individual schools to the Internet. We propose model 3 as the model most appropriate for connecting "hubs" or school districts. We now discuss these models.

4.1 Model 1 - Individual School, Synchronous Dial-In

Technology is just evolving to the point where it is possible cheaply to bring the Internet to the school at a variety of levels. Instrumental in this is the emergence of the Network Applications Technology (NAT) IP router for $1,600. This "plug and play" router provides full IP connectivity for less than the cost of an 8-port terminal server! Furthermore, the circuit connection is able to be scaled using a variety of circuit interfaces, where dial-in using 14,400 baud modems in synchronous mode. Model 1 is the most appropriate place to begin - an inexpensive, scalable approach. The cost of synchronous modems is decreasing dramatically (some at 9.6 kbaud now cost only about $400). Technology is also advancing rapidly. A new standard (v.fast) is under development which will permit transmission speeds of up to 24 kbaud.

Also, modems running in synchronous mode implementing data compression are becoming available with data compression built in (although nonstandard protocols are used). Two modems each running in synchronous mode are required - one each at the local and remote nodes, as shown in Figure 7. Again, note that devices which use nonstandard protocols for data compression and transmission may be problematic (we may assume two identical units will "talk between themselves," but they likely will not "talk" to modems manufactured by other vendors).

Finally, note that a serial interface is required at the hub site. The synchronous modem at the hub site will "plug in" to this (typically via an RS-232 interface). Cisco provides a card with 4 serial interfaces for about $2,700 - thus the per site cost for a serial interface is about $700.

Here, the circuit costs may be minimal (monthly fee of about $12/month), provided the call is local and local calls are not charged by time (depends on the local telephone company and category of service). If the call is long distance, it will be wise to assess typical charges versus purchasing a dedicated digital circuit, such as for Model 2.

4.2 Model 2 - Individual School, 56 kbps Digital Connectivity

Model 2, depicted in Figure 8, is identical to model 1 except that the circuit is a dedicated, digital circuit of speed 56 kbps. For this, the synchronous modems must both be replaced with two CSU/DSU's (Channel Service Unit/Data Service Unit) - much like a digital modem - at a cost of about $500 for each device. However, note that a 56 kbps digital circuit (even tariffed at the cheapest FCC#1 rate) will cost about $100-$150 per month, while dial-in circuits may be free, or much lower in cost if they are not free (however, this depends on length of time connected and whether the call is local or long distance).

Again, a serial interface is required at the hub, as in Model 1.

4.3 Model 3 - Connection to a School District

As shown in Figure 9, we propose to install a larger Cisco gateway at the school district. The Cisco can then be used as the central hub for the school district, connecting many high schools. The NAT can be used only at an end node. We advocate running the network from the school district to all high schools within the district via synchronous dial-in using NAT routers in the high schools, and establishing at all high schools dial-in for the junior high, middle and elementary schools. This model has worked effectively in the PR-1 school district.

This topology, with the Cisco at the "hub" and the NAT at the remote sites, is eminently manageable by the regional network Network Operations Center (NOC). The Cisco provides robust, full-featured routing to the school district. We can use the Cisco to monitor traffic on both sides of it, as well as quality of the connections (errored packets, etc.). Finally, the NAT's on the end nodes can be monitored by the NOC using SNMP. The NAT's have three drawbacks: (1) they are not reachable via telnet, thus they must be configured locally with a terminal, (2) they run only IP, and (3) they must be used at an end node, as they possess only one serial interface. These are not major limitations, as their benefits of: (1) low cost, (2) ease of use, and (3) good performance (up to 2 Mbps) far outweigh the disadvantages.

4.4 Hardware Costs

Table 2 summarizes the hardware costs for each of the above models. Circuit costs will vary depending on location and type of service.

4.5 LAN Technology

There are several technologies for connecting computers to Local Area Networks. We recommend the use of Ethernet for Local Area networks for three reasons: (1) it is inexpensive, (2) it is fairly straightforward to manage, and (3) it is sufficiently fast to enable good transmission (it is rated at 10 Mbps, but typically only 2 to 3 Mbps is realized). Internet Gateways come with a port (plug) for Ethernet. To implement Ethernet locally, one needs: (1) Ethernet cards for the computers ($100 for PC's, about $200 for MAC's), and wiring to connect all the machines together. Wiring for Ethernet comes in three forms: (1) Ethernet thick (we recommend against this), (2) Ethernet thin (we recommend in favor of this), and (3) twisted pair (this is acceptable for limited distances).

Localtalk is Apple's implementation of local area networking, and is rated at 700 kbps (but, again, one gets only about 300 kbps). We recommend against this, and encourage the use of Apple's Ethertalk (their version of Ethernet).

5. Acknowledgment

Much of the technical details for this article was provided by others (we are just collecting it). We thank Dave Menges (dcm@csn.org) of Colorado SuperNet, and Bill Kamm (kamm@yuma.ACNS.ColoState.EDU) and Michael Moravan (moravan@yuma.ACNS.ColoState.EDU) of Colorado State University for their expertise. In particular, Michael Moravan has tested the NAT router with our Cisco gateways, and assured that they inter-operate. We also thank Rob Reilly of MIT (rreilly@ATHENA.MIT.COM) for his incisive review of our connection strategies.

6. Comments

We invite comments on this article. We are not technologists - we just struggle with technology as a means to the end of providing Internet connectivity to the many schools within the Westnet region. We would be pleased to provide additional detail, and most pleased to receive corrections and comments on areas which require clarification. Please send us comments via electronic mail (our addresses appear on page 1 in the title area), or surface mail.

7. Glossary of Acronyms

Appletalk	- Apple's software implementation of local area networking.
Asynchronous	- Data transmission where the devices are not required to be in lock-step (permits only one user at a time to access the Internet, except if a terminal servers or multiplexors.demultiplexers are used at both ends).
Asynchronous Switch	- Hardware allowing one computer at a time to connect to the local modem (locks onto a particular incoming channel).
ARA	- Appletalk Remote Access (software allowing multiple users at a time to connect across one modem connection).
Baud	- Binary Audial Digit (essentially one bit per second over a voice-grade circuit).
bps	- Bit per second (over a digital circuit).
Circuit	-Wire used to transmit data - of two types: (1) voice-grade phone lines accessed via dial-in using asynchronous and synchronous modems, and (2) dedicated digital line accessed via CSU/DSU's.
CSU/DSU	- Channel Service Unit/Data Service Unit (like a digital modem - hardware).
Ethernet	- Hardware implementation for LAN's (most common, high performance and inexpensive).
Gatorbox	- Hardware allowing conversion between Ethernet and Appletalk.
Internet Gateway	- Hardware allowing multiple users to connect directly to the Internet.
kbps	- Thousands of bits per second.
LAN	- Local Area Network.
Localtalk	- Apple's hardware implementation of local area networking.
MAC	- Apple Macintosh Computer.
mbps	- Millions of bits per second.
NAT	- Network Applications Technology (manufactures Internet gateways).
PC	- IBM Personal Computer or Clone.
SNMP	- Simple Network Management Protocol.
Synchronous	- Data transmission requiring timing for all devices to be in lock-step (in full synchronization); with a Gateway, permits multiple machines to access the Internet.
telnet	- Software allowing access across the Internet to remote computers.
Terminal Server	- Hardware allowing multiple users to access the network.
Telebit	- Company manufacturing modems.
V.32	- A communications protocol for modems.
V.32bis	- A communications protocol for modems with enhanced error correction/detection.
V.35	- Hardware interface (cabling) between a gateway and the synchronous modem (cabling, signal conditioning).
WAN	- Wide Area Network (Westnet, for example).

Table 2: Hardware Costs - Models 1 - 3

Model	Item	No. of Units	Unit Cost	Total Cost
1	NAT Router	1	$1,600	$1,600
	Serial Interface	1	$800	$800
	14,400 Synch. Modems	2	$500	$1,400
	TOTAL - Model 1			$3,400
2	NAT Router	1	$1,600	$1,600
	Serial Interface	1	$800	$800
	56 kbps CSU/DSU's	2	$500	$1,000
	TOTAL - Model 2			$3,400
3	Cisco MGS Router	1	$9,700	$9,700
	4S Serial Interface Card	1	$2,700	$2,700
	56 kbps CSU/DSU's	2	$500	$1,000
	TOTAL - Model 3			$13,400

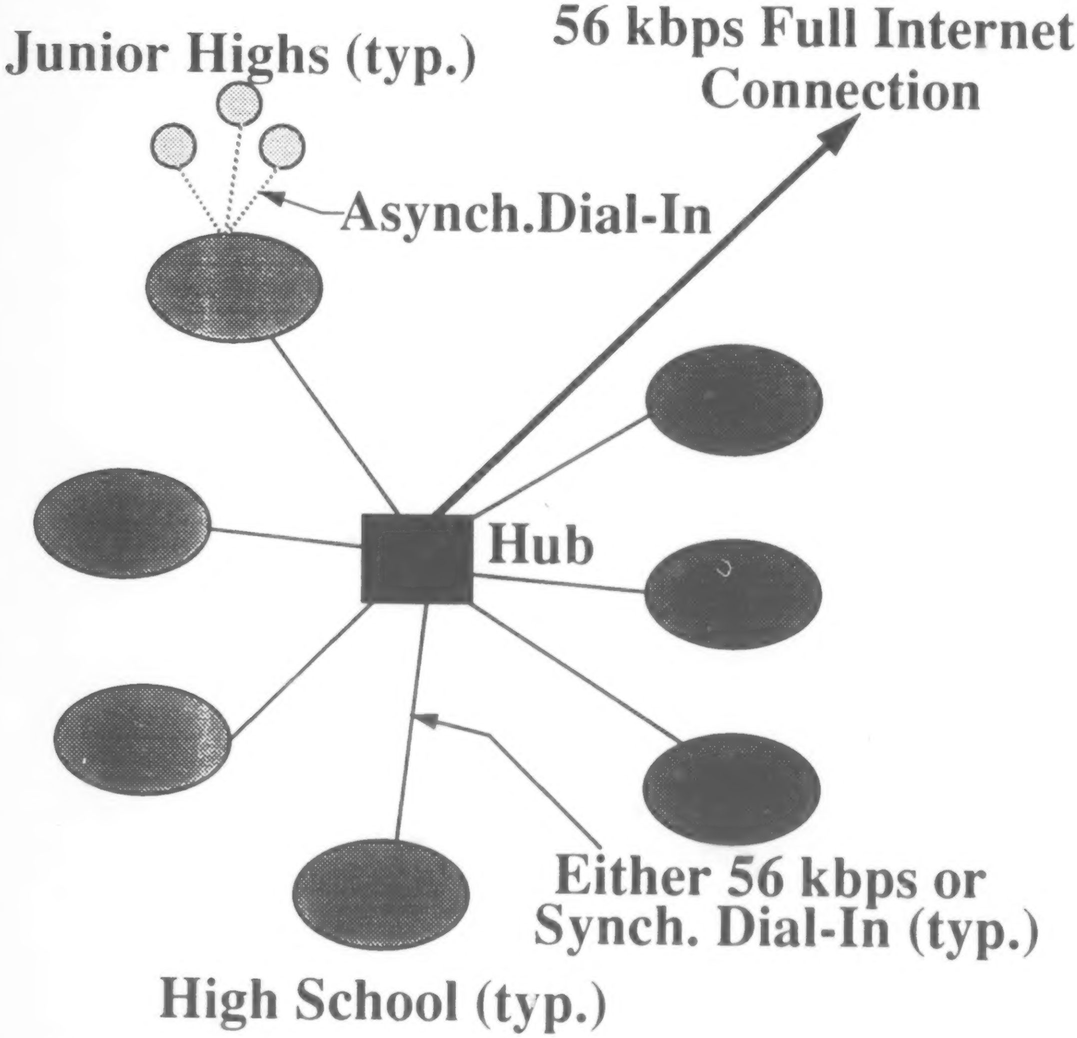

Junior Highs (typ.)
56 kbps Full Internet Connection
Asynch.Dial-In
Hub
Either 56 kbps or Synch. Dial-In (typ.)
High School (typ.)

Figure 5 Connection Topology

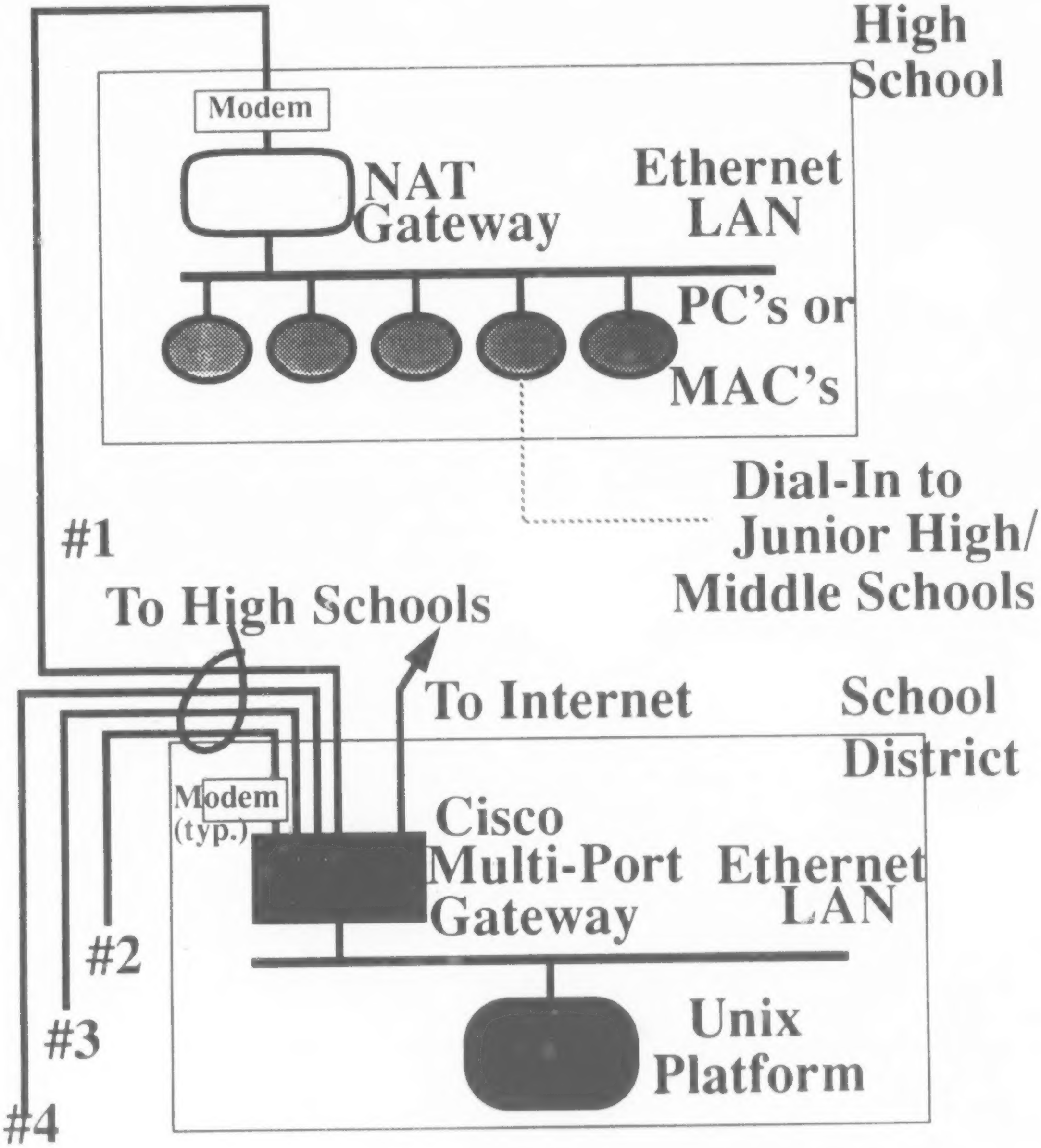
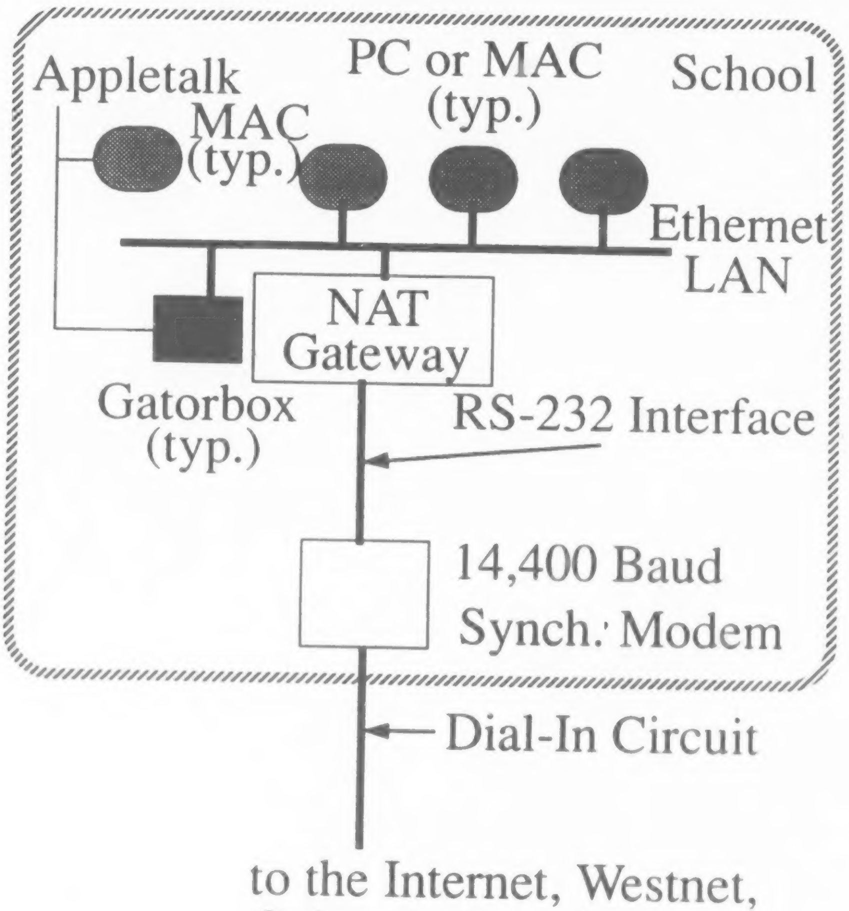

High School
Modem
NAT Gateway
Ethernet LAN
PC's or MAC's
Dial-In to Junior High/ Middle Schools
#1
To High Schools
To Internet
School District
Modem (typ.)
Cisco Multi-Port Gateway
Ethernet LAN
#2
#3
#4
Unix Platform

Figure 6 Internal Details of Connections

FIG. 7 MODEL 1: INDIVIDUAL CONNECTION - SYNCHRONOUS DIAL-IN

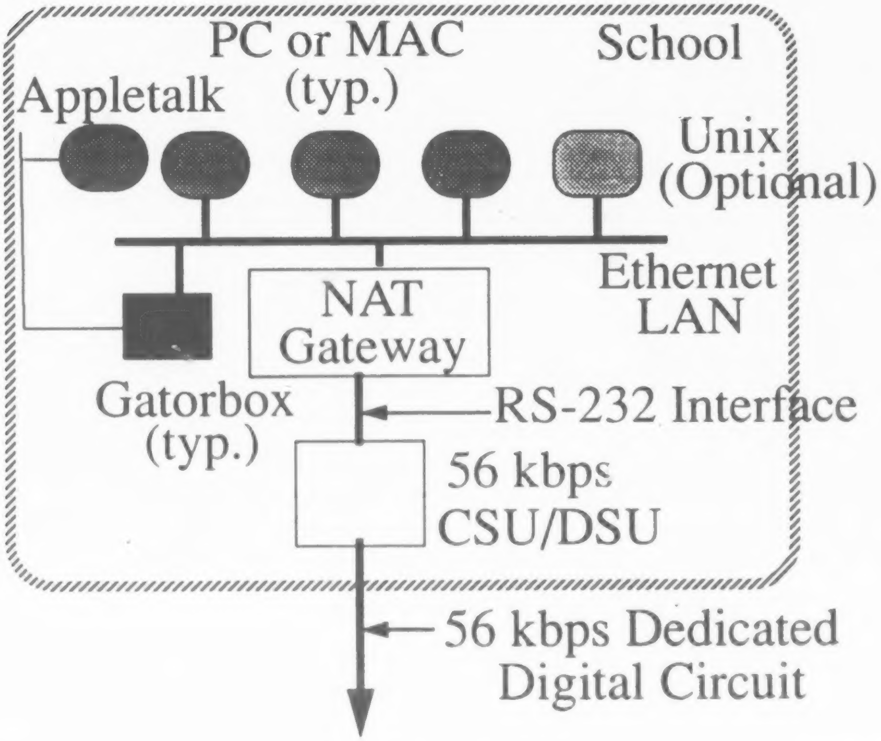

Appletalk
PC or MAC (typ.)
School
MAC (typ.)
Ethernet LAN
NAT Gateway
Gatorbox (typ.)
RS-232 Interface
14,400 Baud Synch. Modem
Dial-In Circuit

to the Internet, Westnet, Colorado SuperNet, etc.

Cost:

NAT Gateway (1 ea.) - $1,600
14.4 kbaud Modem (2@$700) - $1,400
Gatorbox (or equiv.) - $2,100 (optional)
Requires Ethernet/Localtalk LAN at Site and
Serial Port (& Internet Gateway) at Remote Site

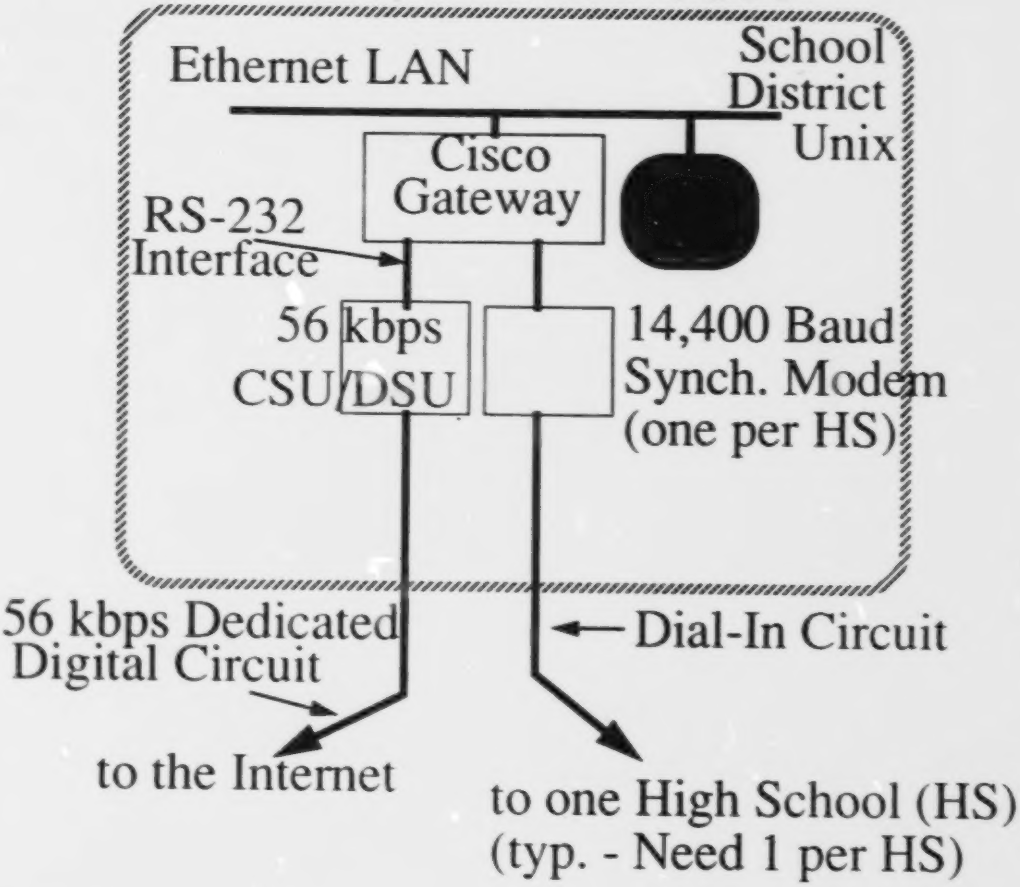
FIG. 8 MODEL 2: INDIVIDUAL CONNECTION - 56 kbps DIGITAL CIRCUIT


PC or MAC
(typ.)
School
Appletalk
Unix
(Optional)
Ethernet
LAN
NAT
Gateway
Gatorbox
(typ.)
RS-232 Interface
56 kbps
CSU/DSU
56 kbps Dedicated
Digital Circuit

to the Internet

Cost:
NAT Gateway (1 ea.) - $1,600
CSU/DSU (2@$500) - $1,000
Circuit: $150/mo. (varies) + installation
Requires Ethernet/Localtalk LAN at Site and
Serial Port (& Internet Gateway) at Remote Site

FIG. 9 MODEL 3: SCHOOL DISTRICT "HUB" CONNECTION - 56 kbps DIGITAL CIRCUIT

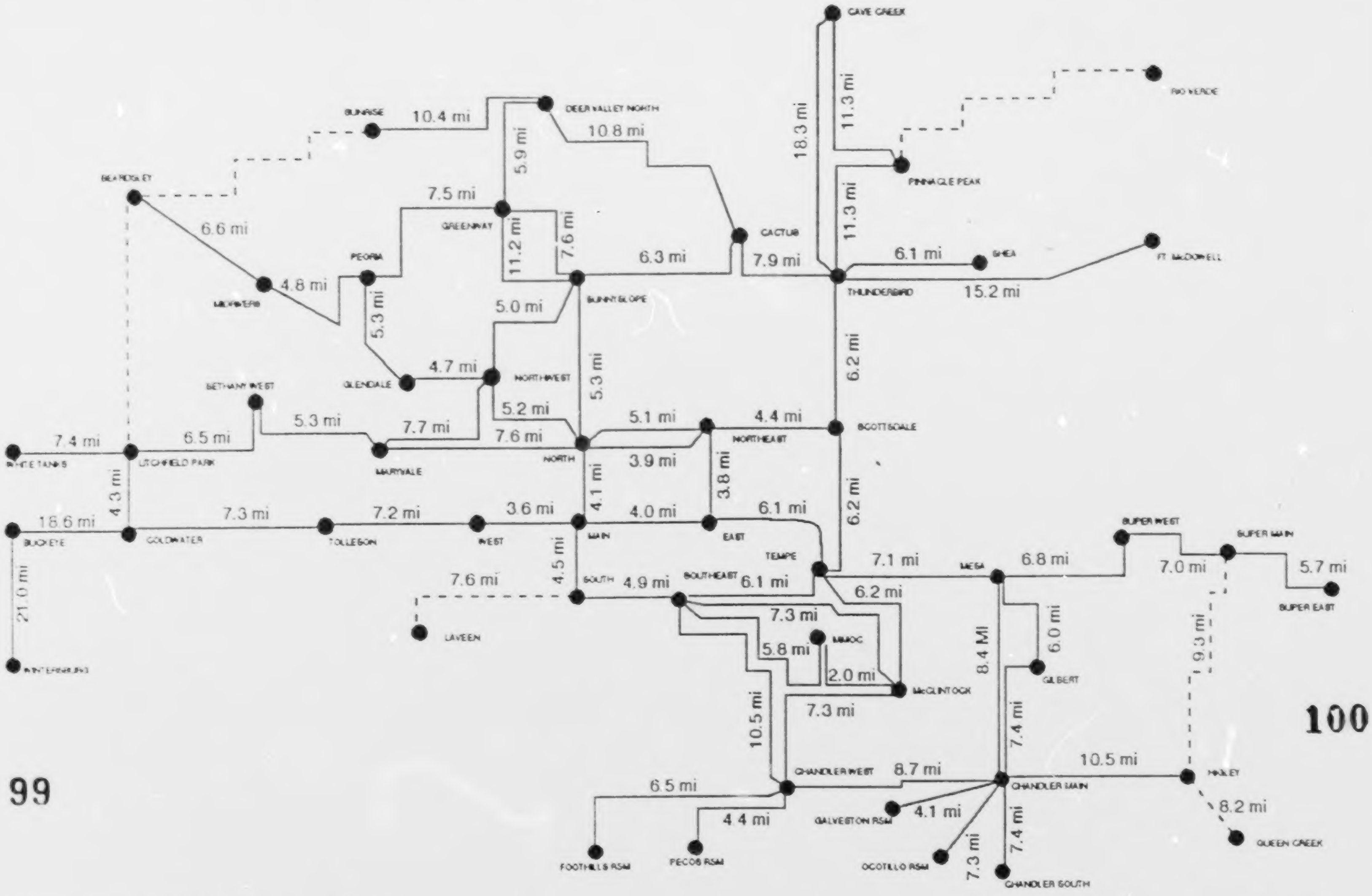

Ethernet LAN
School District Unix
Cisco Gateway
RS-232 Interface
56 kbps CSU/DSU
14,400 Baud Synch. Modem (one per HS)
56 kbps Dedicated Digital Circuit
Dial-In Circuit
to the Internet
to one High School (HS) (typ. - Need 1 per HS)

Cost:

Cisco MGS Gateway - 1E2S (1 ea.) - $9,700
Serial Interfaces for the Cisco (4 ea.) - $2,700
Synchronous Modem (1 per HS) - $500 ea.
CSU/DSU (2@$500) - $1,000
Digital Circuit: $120/mo. + installation

APPENDIX C

Phoenix Metro Fiber Map


CAVE CREEK
RIO VERDE
DEER VALLEY NORTH
SUNRISE
10.4 mi
10.8 mi
5.9 mi
18.3 mi
11.3 mi
BEARDSLEY
PINNACLE PEAK
7.5 mi
11.3 mi
GREENWAY
6.6 mi
11.2 mi
7.6 mi
CACTUS
6.3 mi
7.9 mi
6.1 mi
SHEA
FT. McDOWELL
PEORIA
4.8 mi
MIDWESTERN
SUNNYSLOPE
THUNDERBIRD
15.2 mi
5.3 mi
5.0 mi
6.2 mi
4.7 mi
GLENDALE
NORTHWEST
BETHANY WEST
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5.2 mi
5.3 mi
5.1 mi
4.4 mi
SCOTTSDALE
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6.5 mi
7.7 mi
7.6 mi
NORTHEAST
WHITE TANKS
LITCHFIELD PARK
MARYVALE
NORTH
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4.3 mi
4.1 mi
3.8 mi
6.2 mi
18.6 mi
7.3 mi
7.2 mi
3.6 mi
4.0 mi
6.1 mi
SUPER WEST
SUPER MAIN
BUCKEYE
GOLDWATER
TOLLESON
WEST
MAIN
EAST
TEMPE
7.1 mi
MESA
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7.0 mi
5.7 mi
21.0 mi
7.6 mi
4.5 mi
SOUTH
4.9 mi
SOUTHEAST
6.1 mi
6.2 mi
SUPER EAST
LAVEEN
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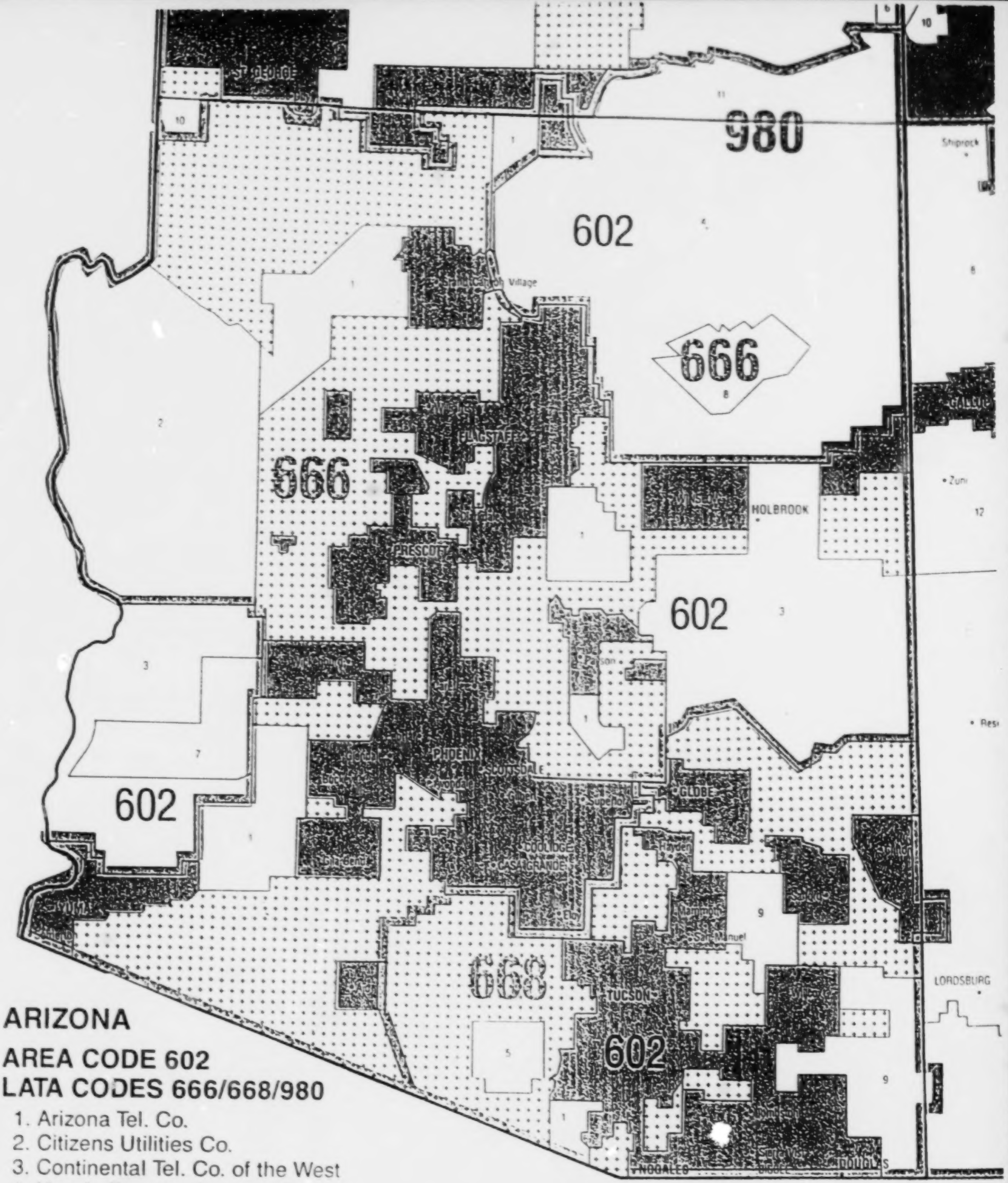
MMOC
6.0 mi
9.3 mi
WINTERSBURG
5.8 mi
2.0 mi
McCLINTOCK
8.4 MI
GILBERT
7.3 mi
10.5 mi
7.4 mi
CHANDLER WEST
8.7 mi
10.5 mi
HIGLEY
6.5 mi
CHANDLER MAIN
GALVESTON RSM
4.1 mi
8.2 mi
4.4 mi
7.4 mi
QUEEN CREEK
FOOTHILLS RSM
PECOS RSM
OCOTILLO RSM
7.3 mi
CHANDLER SOUTH

NOTICE: NOT FOR USE OR DISCLOSURE OUTSIDE OF
U S WEST EXCEPT UNDER WRITTEN AGREEMENT

PHOENIX
SDG/HV/04/15/92

BEST COPY AVAILABLE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602
666
666
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St. George
Grand Canyon Village
Flagstaff
Prescott
Holbrook
Shiprock
Gallup
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Phoenix
Scottsdale
Avondale
Superior
Globe
Hayden
Coolidge
Casa Grande
Eloy
Mammoth
San Manuel
Gila Bend
Yuma
Tucson
Lordsburg
Nogales
Bisbee
Douglas
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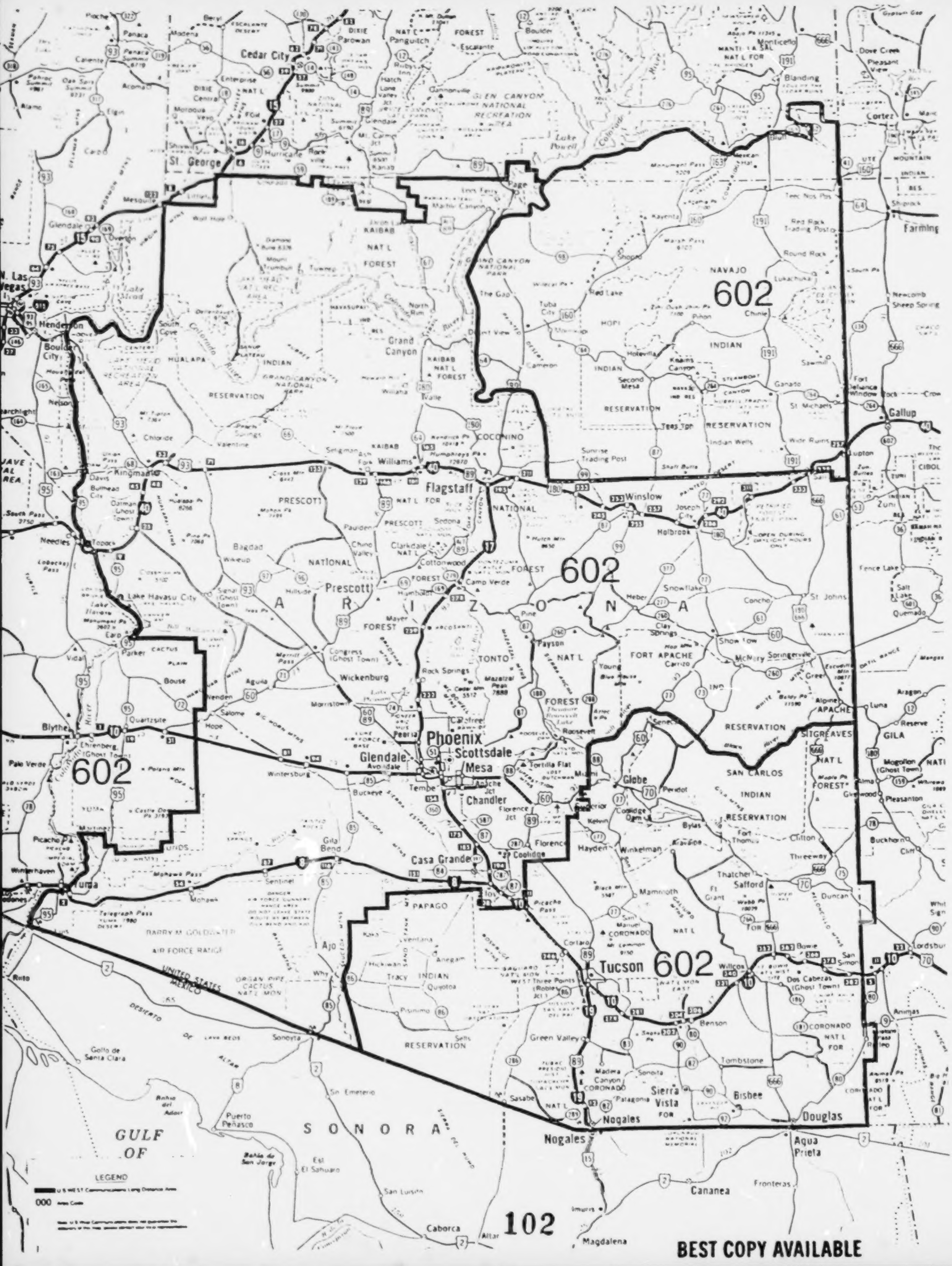
ARIZONA

AREA CODE 602
LATA CODES 666/668/980

1. Arizona Tel. Co.
2. Citizens Utilities Co.
3. Continental Tel. Co. of the West
4. Navajo Communications Co., Inc.
5. Papago Tribal Utility Authority
6. S. Central Utah Tel. Assn., Inc.
7. South Western Tel. Co.
8. Universal Tel. Co. of the Southwest
9. Valley Tel. Coop., Inc.

AREA CODE 801
LATA CODE 660


602
602
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A R I Z O N A
NAVAJO
HOPI
INDIAN
RESERVATION
FORT APACHE
SAN CARLOS
INDIAN
RESERVATION
PAPAGO
INDIAN
RESERVATION
HUALAPAI
INDIAN
RESERVATION
Phoenix
Scottsdale
Mesa
Glendale
Chandler
Tucson
Flagstaff
Prescott
Yuma
Kingman
Winslow
Holbrook
Globe
Safford
Casa Grande
Nogales
Douglas
Bisbee
Sierra Vista
Page
Gallup
Las Vegas
Henderson
St. George
Cedar City
SONORA
GULF OF
LEGEND
U S WEST Communications Long Distance Area
000 Area Code

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TELCO CROSS-REFERENCE LIST

OCN	TELCO NAME
0581	UNITED TEL CO INC
1528	NEBR CENTRAL TEL CO
1576	NE NEBR TEL CO
1595	UNITED TEL SYS - MIDWEST
1632	RESERVATION TEL COOP
1659	GOLDEN WEST
1689	WEST RIVER COOP
1817	PIONEER TEL ASSN INC
1827	S &T TEL COOP ASSN
1835	SUNFLOWER TEL CO INC
2016	PANHANDLE TEL COOP
2066	DELL TELEPHONE CO-OP
2080	GTE OF THE SW
2171	ARIZONA TEL CO
2172	CITIZENS UTIL RURAL CO
2173	PAPAGO TRIBAL UTIL AUTH
2174	SOUTHWESTERN TEL CO
2175	UNIVERSAL TEL CO OF SW
2176	VALLEY TELEPHONE COOP
2177	CONTEL OF THE WEST
2178	AGATE MUT TEL EXCH
2179	GILA RIVER TELECOMM
2181	BIJOU TEL COOP ASSN
2182	THE BLANCA TELEPHONE CO
2184	DELTA COUNTY TELE-COMM
2185	EAGLE TELECOM INC.
2186	EASTERN SLOPE RUR TEL ASN
2187	EL PASO CO. TEL CO
2188	FARMERS TELEPHONE CO
2190	HAXTUN TEL CO
2192	BIG SANDY TELECOMM
2193	NUCLA-NATURITA TEL CO
2194	NUNN TELEPHONE CO.
2196	PEETZ COOP TELEPHONE CO.
2197	PHILLIPS CO. TEL CO
2198	PINE DRIVE TELEPHONE CO.
2199	PLAINS COOP TEL ASSN
2200	FORT MOJAVE TELECOMM
2201	RICO TELEPHONE CO
2202	ROGGEN TEL COOP
2203	RYE TELEPHONE CO.
2204	COLUMBINE TEL CO
2206	STONEHAM COOP TEL CO
2207	STRASBURG TELEPHONE CO.
2208	UNIVERSAL TELEPHONE INC.
2209	WIGGINS TELEPHONE ASSOC.
2210	WILLARD TELEPHONE CO
2213	ALBION TEL CO INC
2215	CAMBRIDGE TEL CO INC
2218	CUSTER TELEPHONE COOP INC
2220	FILER MUT TEL CO
2221	FARMERS MUT TEL CO
2223	GEM STATE UTIL CORP
2225	CENTURY TEL CO OF IDA
2226	MIDVALE TEL EXCH
2227	MUD LAKE TEL COOP INC
2230	POTLATCH TEL CO
2231	PROJECT MUTUAL TEL CO
2232	ROCKLAND TEL CO INC
2233	RURAL TELEPHONE CO.
2234	TROY TEL CO INC
2235	BLACKFOOT TEL COOP
2241	HOT SPRINGS TEL CO
2242	INTERBEL TEL COOP INC
2244	LINCOLN TEL CO INC
2246	MID-RIVERS TEL COOP
2247	NEMONT TEL COOP INC
2248	NORTHERN TEL COOP
2249	NORTHWESTERN TEL SYS
2250	PROJECT TELEPHONE CO.
2251	RANGE TEL COOP
2252	RONAN TELEPHONE COMPANY
2254	SO. MONTANA TEL CO
2255	THREE RIVERS TEL COOP
2257	TRIANGLE TEL COOP
2258	VALLEY RUR TEL COOP
2259	BACA VALLEY TELEPHONE CO
2262	ENMR TEL COOP
2263	LAJICARITA RURAL TEL
2264	LEACO RUR TEL COOP
2268	WESTERN NEW MEXICO TEL CO
2270	PENASCO VALLEY TEL COOP
2272	ROOSEVELT CO. RUR TEL
2274	UNIVERSAL TEL CO OF SW
2275	NAVAJO COMM CO INC
2277	CENTRAL UTAH TEL INC.
2278	EMERY CO. FMRS UNION TEL
2279	GUNNISON TEL CO
2280	KAMAS-WOODLAND TEL CO
2282	MANTI TELEPHONE CO.
2283	SKYLINE TELECOM
2284	BEEHIVE TELEPHONE CO.
2286	SO. CNTRL UTAH TEL ASSN
2287	UINTAH BASIN TEL. CO.
2288	UTAH-WYOMING TELECOM UTAH
2289	CHUGWATER TEL CO
2290	UTAH-WYOMING TELECOM WYO.
2291	DUBOIS TELEPHONE EXCHANGE
2292	EDEN VALLEY TEL CO
2294	MEDICINE BOW TEL CO
2295	SILVER STAR TEL CO
2296	TRI-CO TEL ASSN INC
2297	UNION TELEPHONE COMPANY
2299	WYOMING TELEPHONE CO.
2302	CONTEL OF CALIF
2304	CP NATL TEL SVC CO
2356	RIO VIRGIN TELEPHONE CO.
2392	PINE TELEPHONE SYST
2404	ASOTIN TEL CO
2416	GTE - NORTHWEST
2423	INLAND TEL CO
2456	MALHEUR HOME TEL CO
9533	SOUTHWESTERN BELL
9631	U S WEST COMM (NWB)
9636	U S WEST COMM (MB)
9638	U S WEST COMM (PNB)
9639	
9740	PACIFIC BELL
9999	TYPE II CELLULAR
IATX	AT&T

APPENDIX D

US WEST
COMMUNICATIONS

NETWORK
DISCLOSURE NEWS No. 104

Information for Customer Premises Equipment Manufacturers and Enhanced Services Providers

Implementation of Interchangeable NPA/NXX Code Capability

Disclosure Date: February 24, 1993

Summary:

Due to the pending exhaust of available Numbering Plan Area (NPA) codes for use throughout World Zone 1 (World Zone 1 consists of the United States, Canada and many of the Caribbean administrations), the telephone industry will be required to modify the network to provide the capability to route calls to a new format for NPA codes, termed Interchangeable NPA/NXX codes. The new format will permit the use of digits other than 0 or 1 as the second digit in the area code, a format which until now has been reserved for exchange codes (NNXs). The changes will also permit the assignment of exchange codes which have the format of today's area codes, i.e., a three-digit number with 0 or 1 as a second digit. The latter capability, referred to as "Interchangeable NXX Codes," has already been implemented in Arizona (602 NPA) and in Western Washington (206 NPA) as a means of providing relief when these NPAs exhausted their supply of NNXs.

The targeted completion date for the Interchangeable NPA/NXX codes project is January 1, 1995. No domestic NPA codes with the new format will be assigned prior to that time.

Because of the potential dialing ambiguities which are inherent in the new code formats, it will be necessary for telephone users throughout World Zone 1 to undergo dialing plan changes for toll calls. Callers will no longer be able to dial toll calls within their "home" NPA using the existing "1 + 7-digit" dialing plan. At this time US WEST has received regulatory approval in Arizona (602), Washington (206), Oregon (503), Idaho (208) and Utah (801) to use the "1 + 10-digit"

(continued)

plan in which subscribers will add the home NPA when dialing calls which were formerly 1 + 7-digit calls. Local calls will continue to be dialed using 7 digits only, as is done today. All directly dialed operator-assisted calls, for which customers dial the operator prefix "0" followed by the telephone number, will require the dialing of all 10 digits after the 0.

Many customer premises equipment systems currently in use will not accept or process information which includes NPA data with digits other than 0 or 1 as the second digit. Manufacturers, suppliers, and users of customer premises equipment are encouraged to investigate and, where necessary, upgrade the capabilities of their equipment to deal with Interchangeable NPA/NXX codes. These upgrades generally will not be required prior to the implementation of the dialing plan changes discussed above, but will be required prior to implementation of the first interchangeable NPA code anticipated (per the North American Numbering Plan Administration) to occur in 1995.

Timing of Deployment/ Locations:

As the first phase in the overall implementation of Interchangeable NPA/NXX code capability, US WEST has proposed a schedule of dialing plan changes in Oregon and Idaho which includes a 3 to 4 month "permissive" dialing plan. During the permissive period customers placing toll calls to other locations within their own NPA will be able to dial these calls using either the current dialing plan (1 or 0 plus 7-digits) or the interchangeable plan (1 or 0 plus 10-digits). At the end of the permissive period, calls dialed using the current method will be routed to a recorded announcement indicating that it is necessary to include the home NPA when dialing the call. Shortly before or during the permissive period, users of customer premise equipment, autodialers, alarm systems, etc., should ensure that their systems are reprogrammed to adhere to the new dialing plan.

The following states have agreed to the 1 + 10-digit dialing plan for home NPA dialing of toll calls. The proposed schedules, reflect the start and end of the permissive dialing period.

State	Start	End
Oregon	03/28/93	07/11/93
Idaho	10/17/93	02/27/94
Utah	02/13/94	06/19/94

(continued)

Arizona (602 NPA) and Western Washington (206 NPA) previously adopted the interchangeable dialing plan in 1990 and 1992, respectively, as a method of providing additional NXX codes within their NPAs.

An update to this disclosure will be provided as industry and regulatory approval, if appropriate, is received for new dialing plans within the states served by US WEST.

Additional Information: Customer premises equipment vendors/manufacturers or enhanced service providers desiring additional information regarding the Interchangeable NPA/NXX code expansion should contact their respective US WEST Communications Service Center or call or write to:

Jack Ott
Manager - Numbering Plan Administration Center
1801 California St., Room 450
Denver, CO 80202
(303) 896-1724
FAX (303) 965-1059

APPENDIX E

INTERNET RESOURCES

Library Resources on the Internet: Strategies for Selection and Use

This book focuses on library catalogs available on the Internet and should prove helpful to users who want to expand their research resources.

Farley, Laine, and Engle, Mary
43 pages $20 1992
ISBN 0-8389-7576-3

American Library Association Books
Publishing Services
800/545-2433 • 312/280-5108
fax 312/944-2641

Building Information Infrastructure: Issues in the Development of the National Research and Education Network

Policy research and analysis commissioned by the John F Kennedy School of Government at Harvard University on the creation of new forms of information infrastructure. Covers technological, economic and legal issues.

Kahin, Brian
449 pages $34.95 1992
ISBN 0-390-03083-X

McGraw-Hill/Primis
800/962-9342 • 609/426-5867
fax 609/426-5900

Zen and the Art of the Internet

Aimed at the novice user, this book will serve as a light reference guide to the Internet and should help new users build a foundation for exploring its resources.

Kehoe, Brendan P
112 pages $22 Aug 1992
ISBN 0-13-010778-6

PTR Prentice Hall
515/284-6751 • fax 515/284-2607

Internet: Getting Started

An introduction for newcomers that explains how and why to join the Internet. Includes general coverage of Internet concepts, resources, applications and organizations.

Marine, April
322 pages $28 Feb 1993
ISBN 0-13-327933-2

PTR Prentice Hall
515/284-6751 • fax 515/284-2607

Internet Primer for Information Professionals

Aimed at new network users, this book describes the current state of the Internet with background on NREN initiatives. Covers network concepts, usage, resources and policy issues.

Lane, Elizabeth and Summerhill, Craig
200 pages $37.50 Feb 1993
ISBN 0-88736-831-X

Meckler Corp
203/226-6967
fax 203/454-5840

Internet: Mailing Lists

A comprehensive list of the Internet special interest group mailing lists, with guidelines for accessing and participating in the groups and starting your own group mailing list.

Hardie, Edward T L and Neou, Vivian
311 pages $26 1993 Edition
ISBN 0-13-327941-3

PTR Prentice Hall
515/284-6751 • fax 515/284-2607

Crossing the Internet Threshold: An Instructional Handbook

A practical guide to basic concepts and methods of using the Internet for beginners, with training material to help convey the same concepts to other beginners.

Tennant, Roy; Ober, John; and Lipow, Anne G
Foreword by Clifford Lynch
134 pages $45 Oct 1992
ISBN 1-882208-01-3

Library Solutions Press
510/841-2636 • fax 415/594-0411

The Internet Companion

This concise pocket guide to global networking is written in clear, nontechnical language that is perfect for beginners. Vice President Al Gore contributed to the foreword to this book while he was a U S senator.

LaQuey, Tracy with Ryer, Jeanne C
196 pages $10.95 Oct 1992
ISBN 0-201-62224-6

Addison-Wesley Publishing Co
617/944-3700 • 800/447-2226
fax 617/ 942-1117

Unix, POSIX and Open Systems: The Open Standards Puzzle

A guide to understanding, implementing and using standards, with descriptions of the major standards bodies and POSIX standards. This book discusses how standards are related, how they are made and how users can influence them.

Quarterman, John S and Wilhelm, Susanne
400 pages $43.25 Nov 1992
ISBN 0-201-52772-3

Addison-Wesley Publishing Co
617/944-3700 • 800/447-2226
fax 617/ 942-1117

The Internet Message: Closing the Book With Electronic Mail

The "fourth" in the Marshall Rose trilogy on networking provides plenty of insider information on the current state of Internet mail, and many tales of the history and politics involved. A must read.

Rose, Marshall T
370 pages $44 1993
ISBN 0-13-092941-7

PTR Prentice Hall
515/284-6751 • fax 515/284-2607

Internet System Handbook

A definitive reference guide to the technologies, operation, history and future of the Internet, produced in collaboration with more than 20 distinguished industry pioneers. This hefty book is essential for engineers, managers and network administrators.

Lynch, Daniel C and Rose, Marshall T
790 pages $59.25 1993
ISBN 0-201-56741-5

Addison-Wesley Publishing Co
617/944-3700 • 800/447-2226
fax 617/ 942-1117

The Whole Internet: The User's Guide and Catalog

A guide and catalog on the world's largest computer network.

Krol, Ed
376 pages $ Nov 1992
ISBN 1-56592-025-2

O'Reilly and Associates
103 Morris Street, Suite A
Sebastopol, CA 95472

TCP/IP Network Administration: Help for UNIX system administration

Describes how to set up and administer a network of UNIX systems using the TCP/IP protocols.

Hunt, Craig
470 pages $ Aug 1992
ISBN 0-937175-82-X

O'Reilly and Associates
103 Morris Street, Suite A
Sebastopol, CA 95472

**Network Computing March 1992
Compiled by David Bridge, a system manager for a VAX computer system at the Museum Support Center, which is part of the Smithsonian Institution. He can be reached via the Internet at david@simsdc.si.edu.**

APPENDIX F

AZNET

THE ARIZONA NETWORK

Interlibrary Loan Code, Protocols and Guidelines

Arizona Department of Library, Archives and Public Records
Library Extension Division
State Capitol, 1700 West Washington
Phoenix, Arizona 85007

September, 1992

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Introduction

In May, 1992, the Arizona Department of Library, Archives and Public Records (DLAPR) selected OCLC/AMIGOS Group Access Capability (GAC) to establish a statewide database and to facilitate interlibrary loan (ILL) service to as many libraries as possible. This database is called the Arizona Network (AZNET), which consists of 27 OCLC/AMIGOS/PACNET member libraries and 27 non-OCLC/AMIGOS libraries referred to as Selective Users. Federal LSCA funds are being used to pay for the first year of the statewide information network.

In July, 1992, the AZNET Protocols Task Force was appointed by State Librarian Sharon G. Womack. The charge to the Task Force follows:

1. Recommend policies for the operation of the AZNET database;
2. Review elements that might impact upon statewide resource sharing as a result of the implementation of AZNET;
3. Develop protocols for the sharing of all types of library information among Arizona libraries in keeping with established state and national standards.

AZNET exists to serve the best interest of all its participants. It also means that all participants contribute their share to AZNET's success. No single library or type of library should bear an undue proportion of the ILL volume.

This manual is written with the understanding that as the network grows, new libraries become participants, and the AZNET database expands, the protocols will be continually revised.

A warm thank you to the members of the Protocols Task Force for their support, dedication and insight during the creation of this document. The sense of cooperation was always present even though the group represented all types of libraries of various sizes and had diverse opinions and ideas. Everyone made a contribution.

Access to information is a fundamental right of all Arizona citizens. Since no individual library has the resources available to meet all user needs, interlibrary loan service is maintained. ILL supplements and greatly expands local collections, removes geographic barriers and is essential to libraries of all types and sizes. Successful interlibrary loan service depends on the ability of libraries to identify and locate specific items. Individual libraries in Arizona have created joint union lists and automated databases and subscribed to national automated databases to locate materials throughout the state and elsewhere. Interlibrary loan service has grown and improved. As a result, the need for a coordinated statewide information network has become obvious.

The effectiveness of a statewide system of interlibrary lending is directly related to the equitable distribution of costs among all the libraries involved. Interlibrary loan is an adjunct to, not a substitute for, collection development in individual libraries. It is understood that every library must maintain an appropriate balance between resource sharing and responsibility to its primary clientele.

Each library should provide the resources to meet the ordinary needs and interests of their primary clientele. Material requested should generally be limited to those items that do not conform to the library's collection development policy or for which there is no recurring demand. Borrowing libraries should make every effort to exhaust their resources before resorting to ILL.

Purpose of Interlibrary Loan Code (AZNET Protocols)

The purpose of AZNET is:

- To provide access to library material not available at the patron's library;
- To support the spirit of interlibrary cooperation among all types of libraries by providing a framework for cooperation at the local and state level;
- To facilitate lending and borrowing in Arizona;
- To provide standards, guidelines and protocols for consistent interlibrary loan practice at the local and state level. The protocols should be applied to all AZNET transactions;
- To encourage continued development of high-quality interlibrary loan service to Arizona users;

The policies established in this document are based on accepted national practice, and have been designed to be as liberal and easy to apply as possible.

Reasons for Adopting Statewide Protocols

Adopting a common set of protocols and standards of service will enable Arizona's libraries:

- To cooperate effectively;
- To share resources and expertise;
- To deliver information and materials across the state in a timely manner; and
- To provide consistent and orderly interlibrary loan service to library users.

Definitions of Importance

The following definitions are central ideas for all institutions involved in interlibrary loan activities. Additional terms and their definitions may be found in Appendix A (page 19).

AZNET is the Arizona OCLC/AMIGOS/PACNET Group Access database.

Interlibrary loan is a transaction in which library material is made available from one library to another.

Resource sharing is a broader term. It includes sharing materials (interlibrary loan), expertise, joint purchases, and shared projects among libraries for mutual benefit.

Equity in resource sharing means that each library's contribution to the statewide effort should be proportional to its sharing ability, recognizing that providing information to the citizens of Arizona is the ultimate goal.

Protocols - Guidelines for Members

- The Arizona Interlibrary Loan Protocols have been designed to facilitate lending and borrowing at the local and state level. Lenders may choose to loan any type of material. Borrowers should refer to the written policies of potential lenders before requesting materials.
- Interlibrary loan service is a voluntary, cooperative activity. Each library may determine its own level of participation in regional and statewide resource sharing networks, but libraries accepting state or federal funds to promote resource sharing shall be expected to lend to other Arizona libraries.
- Interlibrary loan should serve as an adjunct to, not as a substitute for, collection development.
- A borrowing library shall exhaust available local resources before initiating interlibrary loan requests.
- Wherever librarians have access to an appropriate countywide, regional, or specialized resource sharing database, they are encouraged to consult it first, before accessing AZNET.
- AZNET members should select small, geographically close libraries for the potential lenders string whenever possible, and avoid making requests of large university or public libraries for material which is available elsewhere.
- **AZNET Lenders String**

  General Guideline:
  Select potential lenders as follows:

  1. Small, geographically close library first
  2. County/District library in your area
  3. Small library anywhere in the state
  4. Large public or academic library
  5. State Research Library (which will be the referral library to go wherever necessary to fill a request).

Specific Search Suggestions:

After having located a bibliographic record for the item that is being searched for, use the following guideline:

No holdings shown - Send to the State Research Library (AZP).

Less than five locations - Set up the search string with the State Research Library as the last in the string (AZP).

More than five locations - Select the first five locations as suggested under the general criteria (Do not use the State Research Library in the string). If the request comes back unfilled after it has been sent to five locations, create a second search string and place the State Research Library (AZP) as the last in the string.

- Do not put the first symbol of the holding library first all the time; vary the holding library symbol so as to not put a heavy burden on the library with the first holding symbol listed.

NOTE: When the request is received by the State Research Library, the staff will then send the request to non-AZNET members. It assumes the request could not be filled by an AZNET member. There is no way for the staff to tell where the request was previously sent.

- Public libraries that are not members of AZNET should refer their interlibrary loan requests to their county/district library.

- School, academic, special and federal libraries that are not AZNET members should individually arrange for an AZNET member to handle requests for them. Possible sources of help are other similar-type libraries or their county/district library.

- State institutions and state agency libraries should direct their requests to the State Library's Research Division.

- Each library in Arizona should develop and present, in written form, its conditions of loan, its cost structure, billing and payment procedures which will become part of this manual. Libraries participating in AZNET will also provide and maintain their policies in the OCLC Name Address Directory (NAD).

Responsibilities of Borrowing Libraries

- The requesting library should exhaust all local resources before resorting to interlibrary loan.

- The requesting library is responsible for determining that material requested is eligible for interlibrary loan within AZNET (See page 11, Eligibility of Requests).

- The requesting library is responsible for certifying that all requests for photocopies meet the provisions of the copyright law (See page 57, Appendix I).

- The due date should be observed and the material returned so that the borrowing library mails it back to the lending library by the due date.

- If a notice is received that material is being sent but the material is not received within ten days, the lending library should be notified.

- Materials should be returned via library rate unless the lending library requests otherwise. If the lending library requests it, materials should be insured.

- A library that receives material intended for another library should forward the material to the intended borrowing library, with a note of explanation.

- The borrowing library is responsible for the safety of borrowed material from the time the material leaves the lending library until it gets back to the lending library. The borrowing library is responsible for packaging the material so as to ensure its return in good condition. If damage or loss occurs, the borrowing library should contact the lending library by phone or by mail regarding procedures for handling/replacing the material. Overdues and replacement costs should be paid within three months of due date.

- Interlibrary loan material should be returned to the library loaning the material so all records can be cleared.

- Material requested shall be described as completely and accurately as possible following accepted bibliographic practice. A source of verification shall be cited for both bibliographic data and location, if possible. For example:

  A. To verify specific citation components (e.g. author, title, etc.), general or specialized indexes, abstracts, directories, bibliographic tools or online databases should be used.

  B. To verify location, union catalogs, computerized databases, OCLC/AMIGOS and other listing services should be used.

C. When items cannot be verified, the statement "cannot verify" should be included along with complete information as to the original source of citation.

- The borrowing library and its users must comply with the conditions of loan established by the lending library.
- Interlibrary loan staff should be aware of the Arizona Library Privacy Act (1985). This act prohibits the disclosure of any library record which identifies a patron and the library materials used or requested by the patron. Exemptions may apply (see appendix V, page 61).
- Blind requests should not be sent to any library. State and federal publication requests may be sent directly to the State Research Library (see definition, page 17).

Responsibilities of Lending Libraries

- The decision to loan is at the discretion of the lending library. Each library is encouraged, however, to interpret as generously as possible its own lending policy with due consideration to the interests of its primary clientele.
- A statement of interlibrary loan policy should be made available upon request. Participants in AZNET should publish and maintain their policies in the OCLC Name Address Directory (NAD) and in the AZNET manual.
- The lending library should process requests promptly. Conditions of loan should be stated clearly and material should be packaged carefully.

If verification is disregarded, or the bibliographic data is incorrect, the lending library may return the request unfilled without special effort to identify the reference.

Eligibility of Requests

A. Available Items

Generally materials may be borrowed from another library if the materials do not conform to the borrowing library's collection development policy and there is not recurring demand for the materials in the borrowing library.

The lending library has the right to decide in each case whether a particular item should be provided and whether the original or a copy should be sent. These decisions may be determined by the nature of the material, its physical condition or the degree of local demand for the material requested.

B. Unavailable Items

In general, libraries should not request the following types of material:

1. Fiction that is in current or recurring demand;
2. Popular material that has been in publication less than one year, including best-sellers, and popular non-fiction;
3. Multiple titles (bulk loans) of books;
4. Reference materials;
5. Rare books;
6. Complete issues of periodicals.

C. A borrowing library should not request more material for any one user than the patron can reasonably use in the loan period. Restrictions may be placed by the lending library on the number of items requested.

D. Material that the borrowing library owns should not be requested unless declared missing.

Costs (Expenses)

The borrowing library assumes responsibility for all costs charged by the lending library. The borrowing library should anticipate charges by referring to established policies and authorize them on the initial request. If no fee information is available, indicate the maximum acceptable fee; if no fee is acceptable, indicate free or $0.

Individual libraries may have fees for photocopying.

Duration of Loan and Turnaround Time

- The loan period, unless otherwise specified by the lending library, is the period of time the item may remain with the borrowing library disregarding travel time.
- Interlibrary loan material should be returned promptly.
- If a library accepts renewals, a request should be sent in time to reach the lending library no later than the due date. If the lending library does not respond, it will be assumed that renewal, for the same period as the original loan, is granted.
- All material on loan is subject to immediate recall, and the borrowing library should comply promptly.
- Libraries should fill ILL requests or communicate their inability to do so within four working days. Whenever possible, libraries should reply whether or not the material is being sent.

Violation of Protocols

AZNET members are responsible for maintaining the provisions of the Arizona 1992 Interlibrary Loan Code, Protocols and Guidelines. Observed non-compliance should be reported to the AZNET Advisory Committee at the Department of Library, Archives and Public Records, Library Extension Division.

Non-compliance of the Arizona Interlibrary Loan Code 1992 Protocols and Guidelines will limit borrowing potential and will severely affect service to patrons at the violating library. Continued disregard of any provision of these Protocols is sufficient reason for suspension of borrowing privileges.

Copyright Compliance

It is the responsibility of each borrowing library to assure the lending library that its requests for photocopies are in full compliance with the Copyright Act of October 19, 1976 (Public Law 94-553). A lending library may refuse to process a photocopy request if it does not conform to copyright guidelines. Much of the photocopying in libraries is covered under Section 108 of the Copyright Act, "Limitations on exclusive rights: Reproduction by libraries and archives." This section notes, in part, that it is not an infringement of copyright for a library, or any of its employees acting within the scope of their employment, to reproduce no more than one copy of a work, or to distribute such copy if (a) the reproduction or distribution is made without any purpose of direct or indirect commercial advantage; (b) the collections of the library are open to the public; and (c) the reproduction includes a notice of copyright. The section further notes that the rights of reproduction and distribution under the section apply to a copy, made from the collection of a library where the user makes his or her request or from that of another library, of no more than one article or other contribution to a copyrighted collection or periodical issue, or to a copy of a small part of any other copyrighted work if (a) the copy becomes the property of the user and the library has had no notice that the copy would be used for any purpose other than private study, scholarship, or research; and (b) the library displays prominently at the place where orders are accepted, and includes on its order form, a warning of copyright. (See Appendix I).

ALA and AMIGOS Interlibrary Loan Codes

The ALA Interlibrary Loan Code is to be followed any time a library wishes to borrow library material from a library within the United States. (See Appendices F and H.)

The AMIGOS Interlibrary Loan Code is a voluntary agreement to govern all ILL among libraries in the AMIGOS network and is intended to promote a more liberal ILL policy among the libraries adopting it than the ALA Code.

The Bibliographic Center for Research (BCR) has an agreement with AMIGOS to honor ILL requests from libraries in each network (See appendix G).

Appendix A

Glossary

AZNET - Arizona Statewide Library Network which includes participating OCLC/AMIGOS libraries and a group of non-OCLC/AMIGOS libraries referred to as "Selective Users".

Blind Request - An ILL request where the borrowing library has not determined ownership by the lending library. Bibliographic information may have been verified.

Borrowing Library - A library desiring to obtain material or other services through interlibrary loan, normally as a service for a patron.

Borrowing Library Code - The symbol, usually a combination of letters, that identifies the library submitting a request.

CCG - Conforms to copyright guidelines.

CCL - Conforms to copyright law.

Copying fee - A charge for services rendered by a library in producing a photocopy or other form of copy of requested material. Normally it will cover the actual costs of the copy; it may include additional costs for personnel time, and in some cases it may include a basic fixed charge, independent of the number of pages.

Copyright Compliance - The borrowing library is responsible for making certain that the request conforms to the copyright law and the accompanying guidelines. A lending library may choose not to process a photocopy request if a representation is not made as to copyright conformity.

Fax - see Telefacsimile.

Fee - A charge made for services, such as photocopying.

GAC - see Group Access Capability.

Government Document - A publication issued by or authorized by a government body and published with public funds.

Group Access Capability - (GAC) extends OCLC ILL Subsystem access to cooperative ILL groups so that all ILL group members can use the OCLC ILL Subsystem to interact with each other.

Holdings - Those items that a library owns. This may refer to titles or to particular volumes of a journal.

ILL - Interlibrary loan.

Incomplete Request - A request which does not include all necessary elements of bibliographic data, such as the date of publication, volume number, etc.

Interlibrary Loan - The lending of material or supplying of photocopies by one library to another library, typically at the request of a patron.

Lending Library - A library that sends or supplies materials requested through interlibrary loan, normally as a service to a patron.

Local System - A computerized online catalog which can, in some cases, be accessed off-site.

OCLC - A bibliographic utility, offering computerized services for libraries; it makes available a large online bibliographic database. The OCLC Interlibrary Loan Subsystem is used for identification of holdings and transmission of requests.

Online - Refers to an information retrieval system which the user queries interactively rather than in a batch mode. In other words, the user and the computer "talk". Usually, the database of information is stored in a central computer memory, and accessed from remote locations by terminals connected to phone lines.

Overdue Material - Material returned to the library after the due date.

Overdue Notice - A message sent to the borrowing library when material has not been received by a lending library by the date established as the "due date".

Periodical - A publication issued in successive parts, each with the same title, but a different number. Most periodicals are issued at regular intervals and in paper covers. Libraries usually secure periodicals on a subscription basis.

Photocopies - The photo reproduction of library materials to be sent in lieu of the original document to fill interlibrary loan requests. In reporting these on statistic forms, the number of citations handled should be recorded, not the number of pages.

Primary Clientele - The group of individuals or institutions to which a library owes its primary responsibility and which is either its source of funding or the group for which the library's services are provided.

Reciprocal Borrowing Agreements - An arrangement by which two libraries mutually agree to exchange library materials on interlibrary loan without any charge to either library.

Reference Collection - A special non-circulating collection of selected materials useful in supplying information, kept together for easy and immediate access.

Reference Work - A publication kept in the reference collection. Usually a work consulted for specific facts and statistical information rather than one to be read at length.

Renewal - The process by which a "due date" may be changed to a later one.

Request - A message sent for the purpose of obtaining an interlibrary loan service such as a loan of material, a photocopy or a reference service. Normally, it will include a bibliographic description of the needed material.

Reserved Book - A book held for a borrower for a certain length of time in response to his request. Some libraries will accept requests for a reserve on a book from other libraries. Also, one of a group of books withheld from general circulation, especially in an academic library.

Selective User - A non-OCLC/AMIGOS library participating in the Arizona Statewide Library Network (AZNET).

Serial - A publication issued in successive years, or at irregular intervals, usually to be continued indefinitely. Included are periodicals, reports, annuals, and numbered monographic series.

Telefacsimile - A method of sending an image of printed or written material from one point to another via telephone lines.

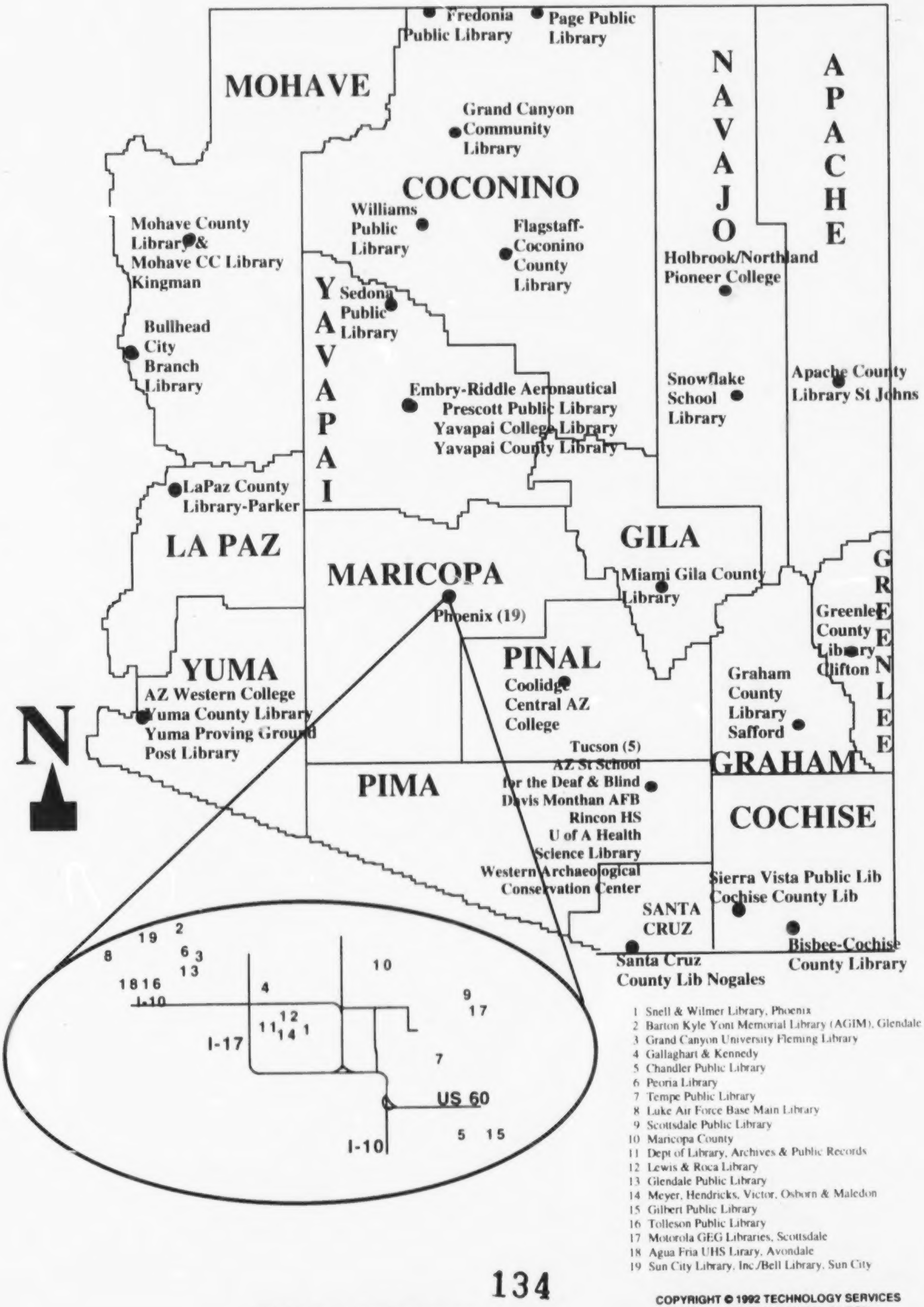
Transaction - Either a filled loan or a filled borrowing (i.e., the activity related to a satisfaction request as accounted for in the borrowing or lending library). A request thus generates two transactions.

Verification - The process of determining whether the bibliographic data on a request is complete and accurate. Also, the term is used for the bibliographic source in which the item is verified, the citation of which should be given on the request form. For example, if an article was verified in *Reader's Guide*, the request form should carry that information together with the volume and page where the article appeared.

Appendix B

AZNET Membership Map

AzNet/OCLC Libraries


Fredonia Public Library
Page Public Library
MOHAVE
Grand Canyon Community Library
COCONINO
NAVAJO
APACHE
Williams Public Library
Flagstaff-Coconino County Library
Mohave County Library & Mohave CC Library Kingman
Holbrook/Northland Pioneer College
YAVAPAI
Sedona Public Library
Bullhead City Branch Library
Snowflake School Library
Apache County Library St Johns
Embry-Riddle Aeronautical
Prescott Public Library
Yavapai College Library
Yavapai County Library
LaPaz County Library-Parker
LA PAZ
GILA
MARICOPA
Miami Gila County Library
GREENLEE
Phoenix (19)
Greenlee County Library Clifton
YUMA
PINAL
Graham County Library Safford
AZ Western College
Yuma County Library
Yuma Proving Ground Post Library
Coolidge Central AZ College
N
Tucson (5)
AZ St School for the Deaf & Blind
Davis Monthan AFB
Rincon HS
U of A Health Science Library
Western Archaeological Conservation Center
GRAHAM
PIMA
COCHISE
Sierra Vista Public Lib
Cochise County Lib
SANTA CRUZ
Santa Cruz County Lib Nogales
Bisbee-Cochise County Library
19
2
8
6
3
13
18
16
I-10
4
10
9
17
12
11
14
1
I-17
7
US 60
5
15
I-10

1 Snell & Wilmer Library, Phoenix
2 Barton Kyle Yont Memorial Library (AGIM), Glendale
3 Grand Canyon University Fleming Library
4 Gallaghart & Kennedy
5 Chandler Public Library
6 Peoria Library
7 Tempe Public Library
8 Luke Air Force Base Main Library
9 Scottsdale Public Library
10 Maricopa County
11 Dept of Library, Archives & Public Records
12 Lewis & Roca Library
13 Glendale Public Library
14 Meyer, Hendricks, Victor, Osborn & Maledon
15 Gilbert Public Library
16 Tolleson Public Library
17 Motorola GEG Libraries, Scottsdale
18 Agua Fria UHS Lirary, Avondale
19 Sun City Library, Inc./Bell Library, Sun City

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Appendix C

AZNET Membership

Selective Users

- Agua Fria Union High School Management
- Apache County Library District
- AZ State School for Deaf and Blind
- Bullhead City Branch Library
- Charles C. Royall Memorial Library
- Clifton/Greenlee County Public Library
- Cottonwood Public Library
- Fredonia Public Library
- Gila County Library District
- Gilbert Public Library
- Grand Canyon Community Library
- Holbrook Public Library
- Mohave Community College Library
- Mohave County Library District
- Motorola GEG Libraries
- Page Public Library
- Parker/La Paz County Public Library
- Pinal County Library District

OCLC Members

- American School of International
- Arizona Western College
- Central Arizona College
- Chandler Public Library
- Cochise County Library District
- Davis Monthan Air Force Base Library
- DLAPR-Research Division
- Embry-Riddle Aeronautical University
- Flagstaff City-Coconino County Public Library
- Gallagher & Kennedy Law Library
- Glendale Public Library
- Grand Canyon University
- Lewis & Roca Law Library
- Luke Air Force Base Library
- Maricopa County Library District
- Meyer, Hendricks, Victor, Osborn, & Maledon Law Library
- Nogales City/Santa Cruz County Public Library
- Peoria Public Library

Appendix C (cont'd)

Rincon/University High School Library

Safford City-Graham County Library

Sedona Public Library

Snowflake School Library

Sun City Library Inc./Bell Library

Tolleson Public Library

Venito Garcia Library

Williams Public Library

Yavapai County Library District

Prescott Public Library

Scottsdale Public Library

Sierra Vista Public Library

Snell and Wilmer Law Library

Tempe Public Library

U of A Health Sciences Library

U. S. Department of the Interior - Western Archaeological and Conservation Center Library

Yavapai College

Yuma County Library District

Appendix D

AZNET Members Symbols

Selective Users

FV4	Agua Fria Union High School Library
FV5	Arizona State School for the Deaf and Blind Library
FV6	Apache County Library District
FV7	Bullhead City Branch Library
FV8	Charles C. Royall Memorial Library
FV9	Clifton-Greenlee County Public Library
FW9	Cottonwood Public Library
FX2	Fredonia Public Library
MM3	Gila County Library District
FX3	Gilbert Public Library
FX4	Grand Canyon Community Library
AZO	Mohave Community College District Library
MC2	Mohave County Library District
MTZ	Motorola GEG Library
HO6	Northland Pioneer College
FX6	Page Public Library
FX7	Parker-La Paz County Public Library
FX8	Pinal County Library District
FX9	Rincon/University High School Library
FY2	Safford City-Graham County Library
FY3	Sedona Public Library
FY4	Snowflake School Library

FY5	Sun City Library, Inc./Bell Library
FY9	Tolleson Public Library
FY6	Venito Garcia Library
FY7	Williams Public Library
YFL	Yavapai County Library District

OCLC Members

AIM	American School of International Management
AZY	Arizona Western College
ZON	Central Arizona College
ZZC	Chandler Public Library
BAZ	Cochise County Library District
TYD	Davis Monthan Air Force Base Library
AZP	DLAPR-Research Division
ERU	Embry-Riddle Aeronautical University
AZH	Flagstaff City-Coconino County Public Library
PGK	Gallagher & Kennedy Law Library
VTL	Glendale Public Library
AZK	Grand Canyon University
LRM	Lewis & Roca Law Library
TYL	Luke Air Force Base Library
MCT	Maricopa County Library District
HEN	Meyer, Hendricks, Victor Osborn, & Maledon Law Library
NSZ	Nogales City/Santa Cruz County Public Library
POR	Peoria Public Library
ZPT	Prescott Public Library
AZD	Scottsdale Public Library
SVZ	Sierra Vista Public Library
SNE	Snell and Wilmer Law Library
ATM	Tempe Public Library
AZA	U of A Health Sciences Library

UKX	U. S. Department of the Interior - Western Archaeological and Conservation Center Library
YVP	Yavapai College
YCC	Yuma County Library District

Central Alabama Community College
Interlibrary Loan Policy

Address to which ILL requests are to be sent:	Interlibrary Loans Thomas D. Russell Library Central Alabama Community College Alexander City, AL 35010
TO ATTENTION OF:	Mrs. Carolyn D. Ingram Circulation & Reference Librarian
Telefacsimile Equipment:	
Telefacsimile Phone Number:	
OCLC Symbol:	ALJ
Books:	Two weeks.
Reference Books:	Do not lend.
Hard Copy Periodicals:	Do not lend--photocopies available.
Audiovisual Materials:	Do not lend.
Microforms:	Do not lend--photocopies available.
Government Documents:	Two weeks.
Other:	
Charges:	No charge for photocopies.
Insurance and Postage:	Postage refund over $1.00.
Loan Period:	Two weeks.
Replacement of Lost Items:	Replace lost items.
Reserves if not available when requested:	
Notification if there will be delays or unable to fill:	Returned ILL form will indicate
Acceptable ILL request formats:	ALA ILL form.
Subject Searches:	None.

Appendix F (cont'd)

Special shipping methods:	None.
Libraries with special ILL arrangements exist:	Local libraries allowed to borrow without using ALA forms.
Average turnaround time for handling:	One day.
Database Searches for general public:	No.
Restrictions:	
In-house Collection Use Allowed:	Yes.
Photocopy Facilities Available:	Yes.
Effective Date:	

Appendix F

AMIGOS Interlibrary Loan Code

AMIGOS Interlibrary Code
May 15, 1981
(Revised March 27, 1992)

This code is a voluntary agreement to govern all interlibrary lending among libraries in the AMIGOS Bibliographic Council, Inc., and is intended to promote a more liberal interlibrary loan policy among the libraries adopting it than that of the ALA National Library Code. It is based on the premise that lending among libraries for the use of an individual served by an AMIGOS member library is in the public interest and should be encouraged. Interlibrary borrowing and lending is regarded by the library subscribing to this agreement as essential to library service since it is evident that it is impossible for any one library to be self-sufficient and that the furtherance of knowledge is in the general interest. However, interlibrary lending should be no substitute for the development of adequate collections based on the needs of the service areas represented in libraries and library systems.

I. *Definition*

Interlibrary loans are transactions in which library materials or copies of library materials are made available by one library to another upon request.

II. *Scope*

Under the terms of this agreement, any type of library material may be requested on loan or in photocopy from another library. The lending library retains the right of deciding in each case whether a particular item should or should not be provided, and whether the original or a copy should be sent.

III. *Responsibility of Borrowing Libraries*

A. It is recognized that interlibrary lending does not relieve any library of the responsibility of developing its own collection. Each library will provide the resources to meet the ordinary

study, educational, instructional, informational and research needs of its users. No library should depend upon another to supply the normal needs of its clients except under special agreement for such service.

B. AMIGOS members will, where feasible and cost-effective following state network protocols, or in the absence of state protocols, exhaust local resources before requesting materials from other members and will route requests to the closest libraries first, taking care to avoid concentrating the burden of requests on a few libraries.

C. The borrowing library is responsible for compliance with the copyright law (Title 17, U. S. Code) and its accompanying guidelines, and should inform its users of the applicability of the law. An indication of compliance must be provided with all copy requests.

D. The safety of borrowed material is the responsibility of the borrowing library from the time the material leaves the lending library until it is returned to the lending library. The borrowing library is responsible for packaging the material so as to insure its return in good condition. If damage or loss occurs, the borrowing library must meet all costs of repair or replacement, in accordance with the preference of the lending library.

E. The borrowing library and its users must comply with the conditions of loan established by the lending library. All material on loan is subject to immediate recall, and the borrowing library shall comply promptly.

F. Unless specifically forbidden by the lending library, copying by the borrowing library is permitted provided that it is in accordance with the copyright law and no damage to the original volume will result.

G. The borrowing library agreeing to abide by this code shall place this data "@/AM" on the request form in these locations:

OCLC - BORROWING NOTES
ALA - Cost Area

IV. *Responsibility of Lending Libraries*

A. The decision to loan material is at the discretion of the lending library. AMIGOS members are encouraged, however, to interpret as generously as possible their own lending policy with due consideration to the interest of their primary clientele.

B. A statement of interlibrary loan policy and charges will be provided to other AMIGOS members upon request. Members will input and regularly update a statement of their policies in the appropriate Name Address Directory records.

C. A lending library is responsible for informing any borrowing library of its apparent failure to follow the provision of this code.

D. AMIGOS members will not require information about the status of the individual for whom material is being requested.

E. All libraries that list themselves as suppliers on OCLC and have signed this code will lend to any other OCLC supplier in the AMIGOS Network through the OCLC ILL Subsystem.

F. Libraries will mail photocopies via First Class Mail. Members are strongly urged to utilize telefacsimile to transmit photocopies for interlibrary loan.

V. *Expenses*

A. The borrowing library should be prepared to assume costs for lost and damaged materials and any other costs not excluded by this code.

B. AMIGOS members will not charge each other for the following: (except charges may be made to non-suppliers)

1. Fees for handling interlibrary loan requests.
2. Postage or other transportation charges, including telefacsimile transmission costs.
3. Photocopying (up to 50 pages per request)
4. Insurance

C. Telephone communications costs will be paid by the telephoning library.

VI. *Violation of the Code*

Each library is responsible for maintaining the provisions of this code in good faith.

Appendix G

BCR Interlibrary Loan Code

This code is a voluntary agreement adopted by the undersigned libraries to govern interlibrary lending among libraries in the BCR Region.

Introduction

Interlibrary loan service is essential to the vitality of libraries of all types and sizes as a means of greatly expanding the range of materials available to users. Lending between libraries is in the public interest and should be encouraged. This code is intended to make interlibrary loan policies among BCR libraries adopting it as liberal and as easy to apply as possible. Interlibrary loan should serve as an adjunct to, not a substitute for, collection development. When resources within the region have been exhausted, loan requests to more distant libraries should then conform to the provisions of the *National Interlibrary Loan Code, 1980.*

I. *Definition*

An interlibrary loan is a transaction in which library material, or a copy of the material, is made available by one library to another upon request.

II. *Purpose*

The purpose of interlibrary loan as defined in this code is to obtain library material not available in the local library.

III. *Scope*

A. A loan or a copy of any material may be requested from another library in accordance with the published lending policy of that library. The lending library will decide in each case whether a particular item can be provided.

B. Most libraries will not ordinarily lend the following types of materials:

1. Rare or valuable material, including manuscripts;
2. Bulky or fragile items which are difficult to ship;
3. Material in high demand at the lending library;
4. Material with local circulation restrictions;
5. Unique material which would be difficult to replace.

IV. *Responsibilities of Borrowing Libraries*

A. Each library should provide the resources to meet the ordinary needs and interests of its primary clientele. Material requested from another library under this code should generally be limited to those items that do not conform to the library's collection development policy or for which there is no recurring demand.

B. Borrowing libraries will make every effort to exhaust their own resources before resorting to interlibrary loans.

C. The interlibrary loan staff of each library should be familiar with, and use, relevant interlibrary loan documents and aids.

D. Each library should inform its users of the purpose of interlibrary loan and of the library's interlibrary borrowing policy. Any member of the borrowing library's clientele should be eligible for interlibrary loan.

E. The borrowing library is responsible for compliance with the copyright law (Title 17, U.S. Code) and its accompanying guidelines, and should inform its users of the applicable portions of the law. An indication of compliance must be provided with all copy requests.

F. Requested material must be described as completely and accurately as possible following accepted bibliographic practice. If an item cannot be verified, the statement "cannot verify" should be included along with information about the original source of citation.

G. Borrowing libraries will make every effort to determine specific locations before sending requests. Blind requests are discouraged; only when efforts to locate material have failed to identify a specific holding library should such a request be placed.

H. Libraries should follow state guidelines for exhausting resources at the state level before requesting from libraries outside their state. Regional resources should be exhausted before going outside the region.

I. Standard interlibrary loan formats should be used for all requests, regardless of the means of transmission.

J. The safety of borrowed materials is the responsibility of the borrowing library from the time the material leaves the lending library until it is received by the lending library. The borrowing library is responsible for packaging the material so as to insure its return in good condition. If damage or loss occurs, the borrowing library must meet all costs of repair or replacement, in accordance with the preferences of the lending library.

K. The borrowing library and its users must comply with the conditions of loan established by the lending library. Unless specifically forbidden by the lending library, copying by the borrowing library is permitted provided that it is in accordance with the copyright law and no damage to the original volume will result.

L. The borrowing library should encourage library users to travel to other libraries for on-site access to material when extensive use of a collection is required or the nature of the material requires special handling. The borrowing library should assist the user in making the necessary arrangements.

M. Participating libraries will make every effort to facilitate fair and equitable distribution of the interlibrary loan load.

V. *Responsibilities of Lending Libraries*

A. The decision to lend material is at the discretion of the lending library. Each library is encouraged, however, to generously interpret its own lending policy with due consideration to the interests of its primary clientele.

B. A statement of interlibrary loan policy and charges will be provided to other BCR members upon request.

C. The lending library should process requests promptly. Conditions of loan should be stated clearly. Material should be packaged carefully. The lending library should notify the borrowing library when unable to fill a request, stating the reason for not filling the request. (For those using OCLC: within the limits of the system.)

D. The lending library should honor the borrowing library's MAXCOST.

E. A lending library is responsible for informing any borrowing library of its apparent failure to follow the provisions of this code.

VI. *Expenses*

A. The borrowing library should be prepared to assume costs for lost and damaged materials and any other costs not excluded by this code and should attempt to anticipate charges and authorize a maximum cost on the initial request.

B. Except under unusual circumstances, BCR libraries party to this agreement will not charge each other:
1. Fees for handling ILL requests.
2. Postage or other transportation charges.
3. Insurance fees.

C. The participating libraries agree to provide 30 free pages per bibliographic citation when photocopying an ILL request. Thereafter, there may be a standard charge of 10¢ per page of photocopy. Charges for articles in excess of 30 pages will be at the discretion of the lenders. Lenders have the option of charging for all pages or only for the pages over 30. (Some libraries may have more liberal agreements; this does not affect such agreements).

D. Telephone communication costs will be paid by the telephoning library.

E. Telefacsimile charges will be left to the discretion of the borrowing and lending libraries.

F. BCR members are encouraged not to charge each other. BCR signatories to this code may charge non-signatories who charge them.

VII. *Duration of Loan*

A. The duration of loan, unless otherwise specified by the lending library, is the period of time the item may remain with the borrowing library disregarding the time spent in transit.

B. Interlibrary loan material should be returned promptly.

C. A renewal request should be sent in time to reach the lending library no later than the due date. If the lending library does not respond, it will be assumed that renewal is granted. However, lenders are urged to respond to such requests.

D. All material on loan is subject to immediate recall, and the borrowing library should comply promptly.

VIII. *Violation of Code*

Each library is responsible for maintaining the provisions of this code in good faith.

Procedures

I. Libraries that have signed the BCR agreement should indicate this by entering "@/BCR" on the request form in these locations:

OCLC - Borrowing Notes
ALA - COST AREA

BCR Libraries using OCLC are also encouraged to enter the fact that they are BCR code signers in the Name Address Directory (NAD), field AFFLN and to have a copy of their lending policies online.

II. Use of OCLC Subsystem

A. Libraries using OCLC/ILL agree to:

1. Supply full bibliographic information on materials not in the database and indicate source(s) for both bibliographic and location information.

2. Send requests to known locations before contacting other libraries.

3. Respond to requests within the allowed time period.

4. Check the message waiting file on a regular basis.

5. Complete COPYRT COMPLIANCE field when requesting photocopies.

6. Observe ILL guidelines in *Interlibrary Loan: User Manual*, 3d ed.

B. Participants will not require information about the status of the individual for whom material is being requested.

III. Libraries signing this code agree to give priority to requests from other BCR libraries under the following conditions:

A. The request is verified according to accepted bibliographic practice, as outlined in Boucher's *Interlibrary Loan Practices Handbook* (ALA, 1984). For periodical requests, this should include volume number, pages, dates, and author and title of article; or

B. The borrowing library indicates the history of its unsuccessful efforts to verify the request and asks for the assistance of the lending library; and

C. The borrowing library identifies itself as a signer of this document.

IV. Participating libraries agree to exchange freely union listings and catalogs of all types and lending policies. (Copying costs may have to be recovered.)

V. All requests and shipments shall be conspicuously labeled "Interlibrary Loan" on the outside of the package. Inside the packaging the loaned material itself shall be clearly identified.

BCR/BSS:CODE. iLL9007

Appendix H

National Interlibrary Loan Code, 1980

Adopted by the Board of Directors of the Reference and Adult Services Division of the American Library Association, June 30, 1980. *Reprinted with permission of the American Library Association; copyright 1981 by the American Library Association.*

Introduction

Interlibrary loan is essential to the vitality of libraries of all types and sizes and is a means by which a wide range of material can be made available to users. This code is designed primarily to regulate lending relations between research libraries and between libraries operating outside networks or consortia. It is recognized that through specific agreements libraries organized geographically, by mutual subject interest, or other bases will have developed codes of their own. It is not the intent of this code to prescribe the nature of interlibrary lending under such arrangements.

The effectiveness of a national system of interlibrary lending is directly related to the equitable distribution of costs among all libraries involved. Interlibrary loan is adjunct to, not a substitute for, collection development in individual libraries. Requests to national and research libraries or requests beyond networks and consortia should only be made after local, state, and regional sources have been exhausted. It is understood that every library must maintain an appropriate balance between resource sharing and responsibility to its primary clientele. The national code contains guidelines for the borrowing and lending of library material. Details of procedures to be used in implementing the code will be found in the *Interlibrary Loan Procedure Manual* published by the American Library Association. [A revision of this manual (Chicago, 1970), originally prepared by Sarah Katharine Thomson for use with the *National Interlibrary Loan Code*, 1968, is now in process.] All libraries participating in interlibrary loan should have copies of this publication and should follow these recommendations. The manual also provides information on international interlibrary loan.

The Reference and Adult Services Division, acting for the American Library Association in its adoption of this code, recognizes that the exchange of material between libraries is an important element in the provision of library service and believes it to be in the public interest to encourage such an exchange.

Definition

An interlibrary loan is a transaction in which library material, or a copy of the material, is made available by one library to another upon request.

Purpose

The purpose of interlibrary loan as defined in this code is to obtain, for research and serious study, library material not available through local, state, or regional libraries.

Scope

A loan or copy of any material may be requested from another library in accordance with the published lending policy of that library. The lending library will decide in each case whether a particular item can be provided.

Most libraries will not ordinarily lend the following types of materials:

1. Rare or valuable material, including manuscripts;
2. Bulky or fragile items that are difficult or expensive to ship;
3. Material in high demand at the lending library;
4. Material with local circulation restrictions;
5. Unique material that would be difficult or impossible to replace.

Responsibilities of Borrowing Libraries

A. Each library should provide the resources to meet the study, instructional, informational, and normal research needs of its primary clientele. This can be accomplished through its own collection or through local, state, or regional cooperative resource-sharing agreements. Material requested from another library under this code should generally be limited to those items that do not conform to the library's collection development policy and for which there is no recurring demand.

B. The interlibrary loan staff of each library should be familiar with, and use, relevant interlibrary loan documents and aids. These include this code, the *Interlibrary Loan Procedure Manual*, lending policies of the major research libraries, and standard bibliographic tools and services.

C. Each library should inform its users of the purpose of interlibrary loan and of the library's interlibrary borrowing policy.

D. The borrowing library is responsible for compliance with the copyright law (Title 17, U. S. Code) and its accompanying guidelines, and should inform its users of the applicable portions of the law. An indication of compliance must be provided with all copy requests.

E. Requested material must be described completely and accurately following accepted bibliographic practice as outlined in the current *Interlibrary Loan Procedure Manual*. If the item cannot be verified, the statement "cannot verify" should be included along with complete information as to the original source of the citation.

F. The borrowing library should carefully screen all requests for loans and reject any that do not conform to this code.

G. Standard bibliographic tools, such as union catalogs, computerized data bases, and other listing services, should be used in determining the location of material. Care should be taken to avoid concentrating the burden of of material. Care should be taken to avoid concentrating the burden of requests on a few libraries.

H. Standard interlibrary loan formats should be used for all requests, regardless of the means of transmission.

I. The safety of borrowed material is the responsibility of the borrowing library from the time the material leaves the lending library until it is received by the lending library. The borrowing library is responsible for packaging material so as to ensure its return in good condition. If damage or loss occurs, the borrowing library must meet all costs of repair or replacement, in accordance with the preference of the lending library.

J. The borrowing library should encourage library users to travel to other libraries for on-site access to material when extensive use of a collection is required or the nature of the material requires special handling. The borrowing library should assist the user in making the necessary arrangements.

Responsibilities of Lending Libraries

A. The decision to loan material is at the discretion of the lending library. Each library is encouraged, however, to interpret as generously as possible its own lending policy with due consideration to the interests of its primary clientele.

B. A statement of interlibrary loan policy and charges should be made available upon request.

C. The lending library should process requests promptly. Conditions of loan should be stated clearly and material should be packaged carefully. The lending library should notify the borrowing library when unable to fill a request, stating the reason for not filling the request.

D. A lending library is responsible for informing any borrowing library of its apparent failure to follow the provisions of this code.

Expenses

A. The borrowing library assumes responsibility for all costs charged by the lending library, including transportation, insurance, copying, and any other service charges. The borrowing library should try to anticipate charges and authorize them on the original request.

B. It is recommended that nominal costs, such as postage, be absorbed by the lending library.

C. If the charges are more than nominal and not authorized by the borrowing library, the lending library should inform the requesting library and ask for authorization to proceed.

Duration of Loan

A. The duration of loan, unless otherwise specified by the lending library, is the period of time the item may remain with the borrowing library disregarding the time spent in transit.

B. Interlibrary loan material should be returned promptly.

C. The borrowing library should ask for renewals only in unusual circumstances. The renewal request should be sent in time to reach the lending library no later than the date due. If the lending library does not respond, it will be assumed that renewal, for the same period as the original loan, is granted.

D. All material on loan is subject to immediate recall, and the borrowing library should comply promptly.

Violation of Code

Continued disregard of any provision of this code is sufficient reason for suspension of borrowing privileges.

Appendix I

Copyright

The Copyright Law

The Copyright Act of 1976, 17 U.S.C. 101 et seq., was a product of many years of intense effort by Congress to replace what many felt was a copyright law which was ill-suited to such technological developments of the twentieth century as cable television, computers, and photocopying machines. One of the most difficult problems to resolve concerned the photomechanical reproduction, in whole or in part, of copyrighted works by libraries and archives. In addition to codifying the doctrine of fair use for the first time (17 U.S.C. 107), the Copyright Act of 1976 contains provisions authorizing certain acts of reproduction and distribution by qualifying libraries (17 U.S.C. 108).

Summary of Section 108

Under section 106 of the Copyright Act of 1976, authors and other owners of copyright are given the exclusive rights, among others, to reproduce the copyrighted work in copies or phonorecords and to distribute copies or phonorecords of the copyrighted work to the public. These exclusive rights are subject to several exemptions, including those contained in section 107 ("fair use") and section 108 ("reproduction by libraries and archives").

Section 108 deals with a variety of situations involving photocopying and other forms of reproduction by libraries and archives. Subsection (a) provides that "...it is not an infringement of copyright for a library or archives, or any of its employees acting within the scope of their employment, to reproduce no more than one copy or phonorecord of a work, or to distribute such a copy or phonorecord, under the conditions specified by this section if:

1. The reproduction or distribution is made without any purpose of direct or indirect commercial advantage;

2. The collections of the library or archives are open to the public or specialized researchers; and

3. The reproduced or distributed material includes a notice of copyright."

Thus, paragraph (a) of section 108 establishes the basic conditions under which a library or archives may claim an exemption from the exclusive rights of copyright proprietors. In addition, for the library activity to be exempt under section 108, one of the other conditions set forth in paragraphs (b) through (f) must be satisfied.

Moreover, under paragraph (h), the exemptions for nonprint copyrighted works are modified substantially. Very generally, with the exception of facsimile duplication for preservation purposes and to replace damaged, deteriorating or lost copies, the exemptions of section 108 apply primarily to books and periodicals.

Archival Preservation (section 108 (b))

This exemption applies only to unpublished works in the current collection of a library or archives. It allows reproduction only in facsimile form, and only for "purposes of preservation or security or for deposit for research use in another library or archives."

Replacement (section 108 (c))

Libraries or archives are authorized to duplicate a published work in facsimile form solely for the purpose of replacement of a copy or phonorecord that is damaged, deteriorating, lost or stolen, but only if it is found that an unused replacement copy cannot be obtained at a fair price. The legislative reports offer some guidance as to what is meant - they indicate that a reasonable investigation will always require recourse to commonly known trade sources in the United States, and in the normal situation also the publisher or copyright owner or to an authorized reproducing service.

Journal Articles, Small Excerpts, Etc. (section 108 (d))

This paragraph applies to "no more than one article or other contribution to a copyrighted collection or periodical issue," or to "...a small part of any other copyrighted work." The only conditions for supplying a reproduction are that: "the copy becomes the property of the user"; there is no reason to suppose that it "would be used for any purposes other than private study, scholarship, or research"; and the library or archives must display prominently, at the place where orders are accepted, and include on the order form, a warning of copyright in language prescribed by a Copyright Office regulation.

Entire Works or Substantial Parts (section 108 (e))

With one addition, the conditions applicable under paragraph (d), as discussed above, apply under paragraph (e) to the "entire work," or "a substantial part of it." The added condition is that "the library or archives has first determined, on the basis of a reasonable investigation, that a copy or phonorecord of a copyrighted work cannot be obtained at a fair price." This paragraph applies essentially to out-of-print works.

General Exemptions (section 108 (f))

In addition to the specific exemptions described above, paragraph (f) makes clear that no copyright liability attaches to a library or its employees for copying done on unsupervised copying machines provided the machines bear a warning that certain copying activity may represent an infringement of the copyright law. Also, nothing in section 108 "in any way affects the right of fair use as provided by section 107," and a small number of copies of an audiovisual news program may be made and distributed in lending.

Multiple and Systematic Copying (section 108 (g))

Section 108 does not permit copying when the library or archives, or its employee:

1. Is aware or has substantial reason to believe that it is making or distributing multiple copies of the same material, whether on one or several occasions; or

2. Engages in the systematic reproduction or distribution of copies of periodical articles or excerpts from other copyrighted works; however, certain copying for interlibrary loan purposes is permissible, even if it might otherwise appear "systematic."

Copying for interlibrary loan purposes is authorized to the extent that libraries receiving copies so made do not do so "in such aggregate quantities as to substitute for a subscription to or purchase of such work." Guidelines for interpretation of the language "such aggregate quantities...were adopted by Congress during its enactment of the Copyright Act...they, as the Act, represent a compromise between proprietary and user interests. Because they were drafted by the interested parties with the administrative support of the National Commission on New Technological Uses of Copyrighted Works (CONTU), they came to be known as the 'CONTU Guidelines.'"

CONTU was a temporary commission which examined certain copyright issues related to computers and photocopying in order to permit Congress to proceed with its revision of the copyright law in general.

The guidelines which were adopted provide, essentially, that copying for interlibrary loan is permissible:

1. If no more than five requests for copies of periodical articles from any given periodical are filled for a requesting library during a calendar year, with respect to articles less than five years old. There is no provision covering the copying of older articles;

2. If no more than five requests for copies of excerpts of any given work are filled for a requesting library within a calendar year; and

3. If requesting libraries state that their requests comply with the Act and keep records of their requests for three years.

Highlights of the Law and Guidelines

1. No more than one article, or ten percent of an entire copyrighted work, whichever is less, may be requested from a copyrighted collection, under normal circumstances.

2. Compliance with the Copyright Law (CCL) or with the CONTU Guidelines (CCG) must be indicated on each interlibrary loan request for photocopy of copyrighted material. Otherwise, lending libraries are obligated to refuse the request.

3. According to the Guidelines, borrowing libraries must retain records of photocopy received for three years beyond the date of the receipt.

4. According to the Guidelines, a borrowing library may receive in one calendar year no more than five photocopies of articles from the last five years of any periodical. Upon the sixth request from a patron it is recommended that the library either subscribe to the journal or attempt to borrow or purchase the entire issue. Alternatively, the borrowing library may obtain the publisher's permission to copy prior to obtaining the photocopy. Photocopying for replacement pages is specifically permitted by the Copyright Act of 1976, and thus is not covered by this provision of the Guidelines.

5. Materials copyrighted and renewed before January 1, 1978 are covered for a maximum of 75 years after the date copyright was originally secured. Works created on.or after January 1, 1978 are covered from creation until 50 years after the author's death. Manuscript materials are thus protected.

6. U.S. government publications may be freely copied under the law.

Further Information

The application of the Copyright Law of 1976 to library photocopying is complex, but there are aids available to its interpretation. A copy of the text of the law should be obtained and kept available for reference. It is available free of charge from the Register of Copyrights, and may be obtained by writing to:

Copyright Office
Library of Congress
Washington, D.C. 20559

In addition, the American Library Association publishes a guide to the copyright law consisting of 12 useful documents dealing with various aspects of its interpretation. Included are pamphlets such as Librarian's Guide to the New Copyright Law, "Guidelines: Records of Interlibrary Photocopying Requests." The documents are available in a slipcase as the Librarian's Copyright Kit, 1982, Chicago: American Library Association, 1982.

Appendix J

Arizona Library Privacy Act

ARS § 41-1354 (Arizona Revised Statutes)

§ 41-1354. Privacy of user records; exceptions; violations; classification

A. Except as provided in subsection B, a library or library system supported by public monies shall not allow disclosure of any record or other information which identifies a user of library services as requesting or obtaining specific materials or services or as otherwise using the library.

B. Records may be disclosed:

1. If necessary for the reasonable operation of the library.
2. On written consent of the user.
3. On receipt of a court order.
4. If required by law.

C. Any person who knowingly discloses any record or other information in violation of this section is guilty of a class 3 misdemeanor.

Added by Laws 1985, Ch. 69, § 1.

Appendix K

Documents and Patents

The State Research Library is the only statutorily-designated depository for Arizona state agency publications. Academic institutions holding substantive collections of state documents include Arizona State University (ASU), University of Arizona (U of A), and Northern Arizona University (NAU). Most collections outside of the State Research Library catalog state documents on the OCLC database.

The only regional depository for federal government publications in Arizona is the State Research Library, which receives all documents included in the depository libraries and receives a percentage of documents included in the depository program (for a complete listing of depository libraries in Arizona, see Appendix J).

Arizona state agency publications and federal government publications may be requested without verification of holdings on OCLC from the State Research Library. The State Research Library can be contacted by telephoning 542-3701 or 1-800-228-4710 or by FAX 542-4400. Libraries also may request publications from local depository libraries provided holdings have been verified.

Federal depository libraries in Arizona can provide basic information about U. S. patents, but the majority of the work in researching patents must be done at a major collection (for example, the Patent Depository Library at Noble Science and Engineering Library, ASU; Phoenix Public Library; and/or Science-Engineering Library, U of A).

The most extensive collection of U. S. patents in Arizona is located in the Patent Depository Library at the Noble Science and Engineering Library, ASU. Library patrons may research this collection, which consists of:

- U. S. utility patents issued since 1790;
- all design patents issued since 1842;
- reissued patents from 1838-1972;
- CDR (Corrections, Disclaimers, Reissues) file from 1973-1987; and
- Patent Status File from 1988 to present.

Libraries may interlibrary loan directly from ASU, using an ALA Interlibrary Form, when a patron has a specific patent number and requires a copy of the patent and related drawings.

FEDERAL DEPOSITORY LIBRARIES IN ARIZONA

Regional Depository:

Arizona Department of Library, Archives and Public Records
Research Division
542-3701
1-800-228-4710

Selective Depository

Arizona State University
Hayden Library
Government Documents Service
965-3387
FAX: 965-9169

Arizona State University
College of Law Library
965-6141
FAX: 965-2467

Central Arizona College
Signal Peak Campus
Learning Resources Center
426-4280
FAX: 426-4284

Glendale Public Library
435-4953
FAX: 931-5662

Grand Canyon University
Fleming Library
589-2420
FAX: 589-2895

Mesa Public Library
644-2702
FAX: 644-3490

Northern Arizona University
Cline Library
523-6802
FAX: 523-3770

Northland Pioneer College
Learning Resources Center
Winslow, AZ
289-4633
FAX: 524-2124

Phoenix Public Library
Federal Documents Section
262-4636
FAX: 495-5841

Tucson-Pima Public Library
Main Library
791-4393
FAX: 791-5248

U. S. Courts Library
Phoenix, AZ
379-3879
FAX: 379-3370

University of Arizona
Main Library
Government Documents Department
621-4871
FAX: 621-9733

University of Arizona
College of Law Library
621-1413
FAX: 621-3138

Yavapai College
Prescott Campus Library
776-2274
FAX: 776-2275

Yuma County Library District
782-1871
FAX: 782-9420

Appendix L

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